1. Algebraic Topology

Marcelo Aguilar *Instituto de Matemáticas, UNAM* A classification of cohomology transfers for ramified covering maps

abstract We construct a cohomology transfer for n-fold ramified covering maps. Then, we define a general concept of transfer for ramified covering maps and prove a classification theorem for these transfers. This generalizes Roushs classification of transfers for n-fold ordinary covering maps. We characterize those representable cofunctors which admit a family of transfers that have two naturalness properties, as well as normalization and stability. This is analogous to Roushs characterization theorem for the case of ordinary covering maps. Finally, we classify these families and give some examples.

Boris N. Apanasov *University of Oklahoma, USA* Fibre bundle structure of almost nilpotent manifolds with pinched negative curvature

abstract The aim of our talk is to describe geometry and topology of manifolds with pinched negative sectional curvature whose fundamental groups are almost nilpotent, especially such noncompact locally symmetric rank one manifolds. Such manifolds classify thin ends of geometrically finite manifolds with pinched negative sectional curvature and play an important role in their geometry. We describe topology of such almost nilpotent manifolds as non-trivial fibre bundles —see B.Apanasov, Almost Nilpotent Manifolds With Pinched Negative Curvature, Preprint No 601, Centre de Reserca Matematica, Bellaterra, 2004. As a tool for this study we use our structural theorem for dynamics of discrete groups acting by isometries on nilpotent groups, see B.Apanasov and X.Xie, Int. J. Math. **8**(1997), 703-757; Diff. Geom. Appl. **20**(2004), 11-29.

Jose Luis Cisneros Molina *Instituto de Matemáticas, UNAM, Unidad Cuernavaca* Stiefel-Whitney classes and singularities

abstract In this talk we give a geometric construction of the Stiefel-Whitney classes of a vector bundle ξ using the singular set of a bundle morphism $h\colon \epsilon^{n-i+1} \to \xi$, with ϵ^{n-i+1} the trivial bundle of rank $n-i+1$. In general the singular set is not a manifold, but for generic h is a stratified manifold and it has a fundamental class. The i-th Stiefel-Whitney class of ξ is the Poincaré dual of such a fundamental class.

T.M. Gendron *Instituto de Matemáticas, UNAM* Geometric Galois Theory, Nonlinear Number Fields and a Galois Group Interpretation of the Idele Class Group

abstract This talk is concerned with the description of geometric parallels of the Galois theory of algebraic number fields. There has been a longstanding metaprinciple that given an algebraic number field K over Q, there should exist a Riemann surface-like object whose field of meromorphic functions may be identified with (a certain complexification of) K. We give the following concrete expression to this meta-principle. After expanding the notion of adele class group to number fields of infinite degree over Q, a hyperbolized adele class group $\mathfrak{S}_K$ is assigned to every number field K/Q. The projectivization of the Hardy space $P\mathsf{H}_\bullet[K]$ of graded holomorphic functions on $\mathfrak{S}_K$ possesses two operations $\oplus$ and $\otimes$ giving it the structure of a *nonlinear number field extension* of K. We show that the Galois theory of these nonlinear number fileds coincides with their discrete counterparts in that $\mathsf{Gal}(P\mathsf{H}_\bullet[K]/K) = 1$ and $\mathsf{Gal}(P\mathsf{H}_\bullet[L]/P\mathsf{H}_\bullet[K]) \cong \mathsf{Gal}(L/K)$ if L/K is Galois.

If K^{ab} denotes the maximal abelian extension of K and C_K is the idele class group, we show that there is an embedding $\mathsf{C}_K \hookrightarrow \mathsf{Gal}_{\otimes}(P\mathsf{H}_{\bullet}[K^{\mathrm{ab}}]/K)$ = the group of $\otimes$-automorphisms of $P\mathsf{H}_{\bullet}[K^{\mathrm{ab}}]$ that fix K. This work is joint with A. Verjovsky.

Samuel Gitler Manifolds of the type of smooth projective algebraic manifolds
abstract S. Gitler with L. Astey, E. Micha and G. Pastor. In this talk I will describe current research on the topology of manifolds of dimension 4n plus 2 which have CPn as 2n skeleton.. These manifold contain twisted projective spaces as cores. We define analogues of complete intersections and try to give a homotopy classification of these, similar to the one we have obtained for algebraic complete intersections.

J. González *Cinvestav* Robotics in lens spaces: an approach to the immersion problem for real projective spaces
abstract Using primary operations in Brown-Peterson cohomology (and in fact just BP-Euler classes) Donald M. Davis obtained in the mid 80's a strong non-immersion result for real projective spaces. Such a result gave new insights on the kind of results one should expect for this extremely difficult problem. In this talk I will explain how to expand this philosophy by considering the immersion problem for (2-torsion) lens spaces. I will discuss possible generalizations of Davis' result and indicate how one can give an alternative (and possibly more manageable) approach to the immersion problem for real projective spaces in terms of the topological complexity of lens spaces, a concept that arises naturally in robotics.

Hiroaki Hamanaka *Department of Natural Science, Hyogo University of Teacher Education* On unstable $\widetilde{K}^1$-theory
Abstract Let $U(n)$ be the unitary group. For a CW-complex X, we define $U_n(X)$ as the homotopy set $[X, U(n)]$ with the group structure defined by the point-wise multiplication. We may call $U_n(X)$ the unstable $\widetilde{K}^1$-theory of X, because, when n is sufficiently large ($2n > \dim X$), $U_n(X)$ merely equals to $\widetilde{K}^1(X)$.

When $\dim X = 2n$, $U_n(X)$ is a central extension of $\widetilde{K}^1(X)$ as follows. Denote the infinite Stiefel manifold $U(\infty)/U(n)$ by W_n and consider the fibration sequence:

$$\Omega U(\infty) \xrightarrow{\Omega p} \Omega W_n \xrightarrow{\delta} U(n) \xrightarrow{i} U(\infty) \xrightarrow{p} W_n. \tag{1.1}$$

Since W_n is $2n$-connected and $\pi_{2n+1}(W_n) = \mathbb{Z}$, the above sequence induces the exact sequence

$$\widetilde{K}^0(X) \xrightarrow{\Theta(X)} \mathrm{H}^{2n}(X) \to U_n(X) \to \widetilde{K}^1(X) \to 0. \tag{1.2}$$

We omit the coefficient ring of cohomology, when it is the integer ring. Concerning with this sequence, the following is known.
Theorem 1.1. [1]

(i) *The sequence* (1.2) *induces the central extension*

$$0 \to \mathrm{Coker}\Theta(X) \to U_n(X) \to \widetilde{K}^1(X) \to 0.$$

(ii) $\Theta(X)$ *is equal to* $n!ch_n$, *where* ch_n *is the* n*-th Chern character.*

Also, the commutator of $U_n(X)$ can be described by means of ordinary cohomology and some characteristic classes ([1]).

Next, when dim$X$ is $2n+1$ or $2n+2$, the situation of $U_n(X)$ depends on whether n is even or odd. Recall the exact sequence obtained by (1.1):

$$\widetilde{K}^0(X) \xrightarrow{\Theta(X)} [X, \Omega W_n] \to U_n(X) \to \widetilde{K}^1(X) \xrightarrow{T(X)} [X, W_n]. \tag{1.3}$$

Here one can see that $[X, \Omega W_n]$ is abelian when dim$X < 4n$, but the following extension induced by (1.3) is not central in general when n is even and dim$X = 2n+1$.

$$0 \to \mathrm{Coker}\Theta(X) \to U_n(X) \to \mathrm{Ker}T(X) \to 0. \tag{1.4}$$

On the other hand the above is central extension when n is odd and dim$X \leq 2n+2$ (See [4]).

When dim$X$ is $2n+1$ and n is odd, one have the result of $U_n(X)$ almost similar to Theorem 1.1([3]).

When dim$X$ is $2n+1$ and even, we should introduce a intermediate group $\check{K}^1(X)$ in general, which is a central extension of a subgroup of $\widetilde{K}^1(X)$, and $U_n(X)$ is a central extension of $\check{K}^1(X)$([3]).

Then, we consider the case dim$X = 2n+2$ and n is odd. We set $W(X) = (1 \oplus \rho^{-1}\mathrm{Sq}^2\rho)(\mathrm{H}^{2n}(X))$ where ρ is the mod 2 reduction.

Theorem 1.2. *Let n be odd and* dim$X \leq 2n+2$. *If* $\mathrm{Tor}(\mathrm{H}^{2n+2}(X), \mathbb{Z}/2) = 0$, *we have the exact sequence:*

$$\widetilde{K}^0(X) \xrightarrow{\Theta'(X)} W(X) \to U_n(X) \to \widetilde{K}^1(X) \xrightarrow{T(X)} \mathrm{H}^{2n+1}(X).$$

Here $T(X) = \Sigma^{-1}c_{n+1}$, c_{n+1} *is the* $n+1$*-th Chern class and* $\Theta'(X) = (n)!ch_n \oplus (n+1)!ch_{n+1}$.

Also the commutator of $U_n(X)$ can be described by means of ordinary cohomology and some characteristic classes. Using these result, $U_n(X)$ can be determined for several spaces .

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Norio Iwase *Kyushu University, Japan* L-S category of principal fibre bundles

abstract We give new lower and upper estimates for L-S category of principal fibre bundles, which implies some results on L-S category of spinor groups.

Yasuhiko Kamiyama *University of the Ryukyus* Configuration spaces and rational functions

abstract

Definition 1 . We set

$$P^l_{k,n} = \{f(z) = z^k + a_1 z^{k-1} + \cdots + a_k : a_i \in \mathbf{C}, \\ \text{the number of } n\text{-fold roots of } f(z) \text{ is at most } l\}.$$

Here two n-fold roots may coincide. We write $P^0_{k,2}$ as $C_k(\mathbf{C})$.

Example 1 .

(1) For $l \geq d$, $P^l_{nd,n} = \mathbf{C}^{nd} \simeq \{\text{a point}\}$.
(2) $P^{d-1}_{nd,n} \cong \mathbf{C}^{nd} - \mathbf{C}^d \simeq S^{2(n-1)d-1}$.

Definition 2 . We set

$$X^l_{k,n} = \{(p_1(z),\dots,p_n(z)) : \text{each } p_i(z) \text{ is a monic polynomial over } \mathbf{C} \text{ of degree } k \text{ and such that there are at most } l \text{ roots common to all } p_i(z)\}.$$

Here two common roots may coincide. We write $X^0_{k,n}$ as $\mathrm{Rat}_k(\mathbf{C}P^{n-1})$.

Example 2 .

(1) For $l \geq d$, $X^l_{d,n} = (\mathbf{C}^d)^n \simeq \{\text{a point}\}$.
(2) $X^{d-1}_{d,n} \cong (\mathbf{C}^d)^n - \{\text{diagonal set}\} \simeq S^{2(n-1)d-1}$.

$\boxed{\text{Homotopy fiber}}$

(1) $J^l(2n-2)$: the l-th stage of the James construction which builds ΩS^{2n-1}.
(2) $W^l(n)$: the homotopy theoretic fiber of the inclusion $J^l(2n-2) \hookrightarrow \Omega S^{2n-1}$.

$$W^l(n)@>>> J^l(2n-2) \hookrightarrow \Omega S^{2n-1}.$$

(3) We can generalize Snaith's stable splitting as follows.

$$W^l(n) \underset{s}{\simeq} \bigvee_{1\leq q} D_q\xi^l(n).$$

Teorem There is an unstable map $\alpha^l_{k,n} : X^l_{k,n} \to W^l(n)$ which is a homotopy equivalence up to dimension $\left[\frac{k}{l+1}\right](2(l+1)(n-1)-1)$.

Teorem

$$X^l_{k,n} \underset{s}{\simeq} \bigvee_{q=1}^{k} D_q\xi^l(n).$$

Theorem 2 for $l = 0$ is the theorem of Cohen et al.

TeoremExcept when $(n,l) = (2,0)$, there is a homotopy equivalence

$$P^l_{k,n} \simeq X^l_{[\frac{k}{n}],n}.$$

Theorem 3 for $l = 0$ is essentially the theorem of Vassiliev. Combining the results of Brown-Peterson and Cohen et al., Theorem 3 holds stably when $(n,l) = (2,0)$. Note that Theorem 3 indeed holds between Examples 1 and 2.

2. Tables

The following tables are taken from V.I. Arnold: On some topological invariants of algebraic functions. Trudy Moscov. Mat. Obshch. **21**, 27–46 (1970); English transl. in Trans. Moscow Math. Soc. **21**, 30–52 (1970). Stability Theorem: Fix q. In each column, we go downward. Then the homology stabilizes when $k \geq 2q$.

$\boxed{H_*(P^{k-1}_{2k+i,2};\mathbf{Z})}$

(1) For $1 \leq q \leq 2k-2$, $H_q(P^{k-1}_{2k+i,2};\mathbf{Z}) = 0$.
(2) For $2k-1 \leq q \leq 2k+3$, $H_q(P^{k-1}_{2k+i,2};\mathbf{Z})$ are cyclic and the orders are given by the following table.

Here

TABLE 1. The groups $H_q(C_k(\mathbf{C});\mathbf{Z})$ $(1 \le q \le 5)$.

$k \setminus q$	1	2	3	4	5
$0,1$	0	0	0	0	0
$2,3$	$\mathbf{Z}$	0	0	0	0
$4,5$	$\mathbf{Z}$	$\mathbf{Z}/2$	0	0	0
$6,7$	$\mathbf{Z}$	$\mathbf{Z}/2$	$\mathbf{Z}/2$	$\mathbf{Z}/3$	0
$8,9$	$\mathbf{Z}$	$\mathbf{Z}/2$	$\mathbf{Z}/2$	$\mathbf{Z}/6$	$\mathbf{Z}/3$
$10,11$	$\mathbf{Z}$	$\mathbf{Z}/2$	$\mathbf{Z}/2$	$\mathbf{Z}/6$	$\mathbf{Z}/6$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
∞	$\mathbf{Z}$	$\mathbf{Z}/2$	$\mathbf{Z}/2$	$\mathbf{Z}/6$	$\mathbf{Z}/6$

TABLE 2. The orders of the groups $H_q(P^{k-1}_{2k+i,2};\mathbf{Z})$ $(2k-1 \le q \le 2k+3)$.

$i \setminus q$	$2k-1$	$2k$	$2k+1$	$2k+2$	$2k+3$
$0,1$	∞	0	0	0	0
$2,3$	∞	$k+1$	0	0	0
$4,5$	∞	$k+1$	$2/k$	$(k+2)/2$	0
$6,7$	∞	$k+1$	$2/k$	$((k+2)/2)(2/k)$	$3/k$
$8,9$	∞	$k+1$	$2/k$	$((k+2)/2)(2/k)$	$6/kv$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
∞	∞	$k+1$	$2/k$	$((k+2)/2)(2/k)$	$6/kv$

(i) We introduce the notation
$$a/b = \frac{a}{\gcd(a,b)},$$
where $\gcd(a,b)$ is the greatest common divisor of the integers a and b.

(ii) Stability Theorem: Fix k and q. In each column, we go downward. Then the homology stabilizes when $i \ge 2(q-2k+1)$.

(iii) We have
$$v = \begin{cases} 1 & \text{if } k \not\equiv 1 (\operatorname{mod} 4) \\ 1 \text{ or } 2 & \text{if } k \equiv 1 (\operatorname{mod} 4). \end{cases}$$
But the exact value is left unknown.

Table 1 is obtained from Table 2 by setting $k = 1$ and rewriting $2k+i$ as k.

$\boxed{\text{Reconstruction of Table 2}}$

(1) By Theorem 3,
$$P^{k-1}_{2k+i,2} \simeq X^{k-1}_{k+\left[\frac{i}{2}\right],2}.$$
Hence we calculate the right-hand side.

(2) By Theorem 2, as a vector space, $H_*(X^{k-1}_{k+\left[\frac{i}{2}\right],2};\mathbf{Z}/p)$ (where p is a prime) is isomorphic to the subspace of $H_*(W^{k-1}(2);\mathbf{Z}/p)$ spanned by monomials of weight $\le k+\left[\frac{i}{2}\right]$.

(3) We can determine $H_*(W^{k-1}(2);\mathbf{Z}/p)$ from the mod p Serre spectral sequence for the fibration

$$\Omega^2 S^3 \to W^{k-1}(2) \to J^{k-1}(2).$$

(4) If we follow the steps (1)-(3), then we can prove that the value of the indeterminacy v in Table 2 is 1 when $k \equiv 1(\text{mod}\,4)$.

Akira Kono *Department of Mathematics Kyoto University* Homotopy type of gauge groups of $SU(3)$-bundles over S^6

abstract Let G be a compact Lie group, $\pi : P \to B$ a principal G-bundle over a finite complex B. The group of G-equivariant self-maps covering the identity map of B is called the gauge group of P. The purpose of this talk is to show the following:

THEOREM.Denote by ϵ' a generator of $\pi_6(BSU(3)) \cong \mathbb{Z}$ and by $\mathcal{G}_k$, the gauge group of the principal $SU(3)$-bundle over S^6 classified by $k\epsilon'$. Then $\mathcal{G}_k \simeq \mathcal{G}_{k'}$ if and only if $(120, k) = (120, k')$.

Ernesto Lupercio *Cinvestav* Orbifold String Topology

abstract In this talk I will present the theory of orbifold string topology (developed in collaboration with B. Uribe and M. Xicotencatl). In a seminar paper a few years ago M. Chas and D. Sullivan discovered a BV-algebra structure in the homology of the free loop space of a symplectic manifold. This was transposed to the homotopy theory realm by R. Cohen and J. Jones. Here I will introduce the original theory, its relation to quantum field theory (Cohen-Godin). Then thinking of a group action as a topological Deligne-Mumford stack I will explain how we have developed the orbifold (equivariant) version of the theory inspired by the work of Chen-Ruan and that of Dixon-Harvey-Vafa-Witten. This relates to the original theory much in the way in which equivariant K-theory relates to K-theory. Finally I will turn on the physicist flat B-field known as discrete torsion.

G. Moreno *Cinvestav* TBA

Frank Neumann *Department of Mathematics, University of Leicester, United Kingdom* On the algebraic K-theory of the category of unstable modules over the Steenrod algebra

abstract Using the Gabriel-Krull filtration, we construct a spectral sequence of homological type converging to the algebraic K-theory of the Noetherian objects in the category of unstable modules over the Steedrod algebra. This is in direct analogy with the Brown-Gersten-Quillen spectral sequence converging to the algebraic K-theory of a Noetherian scheme via the codimension of support filtration.

Ivonne J. Ortiz *Miami University* The lower algebraic K-theory of Γ_3

abstract We will present the lower algebraic K-theory of Γ_3 a discrete subgroup of the group of isometries of hyperbolic 3-space. This group forms part of a family of hyperbolic, non-cocompact, n-simplex reflection groups from which to study the problem of computing the K-theory of infinite groups with torsion. The main result is that for Γ_3, the Whitehead group of Γ_3 is zero, $\tilde{K}_0(\mathbb{Z}\Gamma_3) = Z/4 \oplus Z/4$, $K_{-1}(Z\Gamma_3) = Z \oplus Z$ and $K_n(Z\Gamma_3)$ is zero for all $n < -1$.

Andres Pedroza *Universidad de Colima* A Generalization of the localization formula *abstract* We will present a generalization of the Atiyah-Bott-Berline-Vergne localization theorem for the equivariant cohomology of a torus action: replacing the torus action by a compact connected Lie group action. This provides a systematic method for calculating the Gysin homomorphism in ordinary cohomology of an equivariant map.

Mikhail Shchukin *Belarusian state university* About the K-theory of n-homogeneous C^*-algebras
abstract The classical result by Gelfand and Naimark describes the K-theory of commutative C^*-algebras as the K-theory of the space of maximal ideals of the algebra. We extend the result for the class n-homogenous C^*-algebras. We say that the algebra A is n-homogeneous if all its irreducible representations are of dimension n for some positive integer n. We prove that the K-theory of a n-homogeneous C^*-algebra is canonically isomorphic to the K-theory of the space of primitive ideals of the algebra A in the appropriate topology.

Dai Tamaki *Department of Mathematical Sciences, Shinshu University* On the E^1-term of the gravity spectral sequence
abstract The author constructed a spectral sequence strongly converging to $h_*(\Omega^n\Sigma^n X)$ for any homology theory in 1994. In this talk, we prove that the E^1-term of the spectral sequence is isomorphic to the cobar construction, and hence the spectral sequence is isomorphic to the classical cobar-type Eilenberg-Moore spectral sequence based on the geometric cobar construction from the E^1-term. Similar arguments can be also applied to its variants constructed in 2002 by the author.

Shuichi Tsukuda *University of the Ryukyus* On the mod 2 cohomology of Map(X,BSp(n))
abstract In this talk, we describe the ring structure of the mod 2 cohomology of the mapping space $Map(S^4, BSp(1))$ from 4-dimensional sphere to the classifying space of $Sp(1)$. We also study the action of the Steenrod algebra. As an application, we show the non triviality of certain evaluation fibrations.

Miguel A. Xicotencatl *CINVESTAV, Instituto Politécnico Nacional* Homology calculations and operadic structure in orbifold string topology.
abstract In recent work (with B. Uribe and E. Lupercio) we have developed an "orbifold analogue" of the Chas-Sullivan product in the homology of the free loop space of a manifold. In this talk I will present explicit calculations in the string homology ring of the free loop space of classifying space of an orbifold. Also, I will show that the homology of the orbifold loop space can be given a natural action of the cactus operad, and thus it inherits a BV-algebra structure.

3. Geometric Topology

Tatsuya Arai *Tsukuba College of Technology* P-chaos implies distributional chaos and chaos in the sense of Devaney with positive topological entropy
abstract Tatsuya Arai(speaker) and Naotsugu Chinen . Let f be a continuous map from a compact metric space X to itself. The map f is called to be P-chaotic if it has the pseudo-orbit-tracing property and the closure of the set P(f) of all periodic points for f is equal to X. We show that every P-chaotic map from a continuum to

itself is chaotic in the sence of Devaney and distributionally chaotic with positive topological entropy.

Sergey A. Antonyan *Facultad de Ciencias, Universidad Nacional Autónoma de México* Characterizing equivariant ansolute retracts

*abstract*For a compact Lie group G, we give a characterization of G-ANR's and G-AR's in terms of the H-fixed point sets, where H runs the family of closed subgroups of G. Applications will be presented.

Alexander Bykov *Universidad Autńoma de Puebla* Equivariant Cotelescopes and Fibrant Spaces

abstract The general approach to the concept of *a fibrant object* is the following: if in a category $\mathcal{C}$ some class Σ of morphisms is specified then an object Y of $\mathcal{C}$ is called Σ-fibrant if for every morphism $s \in \Sigma$, $s : A \to X$, and every morphism $f : A \to Y$ there is a morphism $F : X \to Y$ such that $F \circ s = f$. The classical fibrant objects appear in [5] for the closed model categories where Σ is the class of trivial cofibrations. *A fibrant space* in the sense of F.Cathey is a Σ-fibrant object, where Σ is the class of $SSDR$-maps in the category of metrizable spaces ([2]). In the talk we provide an equivariant version of a fibrant space. It is well-known ([4]) that every compact metrizable group can be represented as an inverse limit of a sequence of Lie groups bonded by fibrations, and therefore it is already a fibrant space in the sense of F.Cathey. On the other hand, due to R.Palias ([3]), every compact Lie group G is a G-ANR and hence it is a G-fibrant space. These are the basic facts utilized in the proof of our result: every compact metrizable group G is a G-fibrant space. Also equivariant fibrants naturally appear as cotelescopes of inverse sequences of G-ANRs. Equivariant cotelescopes as well as equivariant $SSDR$-maps and the results of [1] can be used in the construction of the equivariant strong shape category following the way of F.Cathey. All these facts justify the consideration of equivariant fibrant spaces.

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Robert Cauty *Université de Paris VI, Pierre et Marie Curie* Algebraic ANRs

abstract Lefschetz's criterion characterizes ANRs among metrizable spaces in terms of realizations of simplicial complexes. They are continuous maps from simplicial complexes into the space. We study the class of metrizable spaces which one obtains replacing in this criterion the continuous maps from complexes K to the space X by chain morphisms from the ordered chain complex of K to the singular chain complex of X. This new class contains the ANRs but also all locally equiconnected metric spaces.

Robert J. Daverman *University of Tennessee* Manifolds homotopically determined by their fundamental groups *abstract* A manifold N is said to be homotopically determined by its fundamental group if each map $f : N \to N$ which induces a π_1-isomorphism is a homotopy equivalence. Aspherical manifolds obviously have this feature. More generally, in a 1974 paper G. A. Swarup characterized the

closed, orientable 3-manifolds with this property as those having a connected sum decomposition with at least one aspherical factor. This talk will explore examples, non-examples and construction techniques in all dimensions. A typical Theorem is the following near-generalization of Swarup's result: If $N = N_1 \# N_2$ is a closed, orientable, Hopfian n-manifold such that N_1 is aspherical and $\pi_1(N_2)$ has no free factor in any free product decomposition, then N is homotopically determined by its fundamental group. Much of the work on the topic is joint with Y. Kim.

Tadeusz Dobrowolski *Pittsburg State University, U.S.A.* Near-selections and extensions without local convexity *abstract* The aim of the talk is to characterize the AR-property in convex subsets of metric linear spaces without local convexity. This will be done in terms of certain near-selections. Roughly speaking, the characterization theorem states that a convex set in a metric linear space is an AR if and only if lower semi-continuous functions with finite-dimensional compact convex values admit near selections. Applications will be presented. This is a joint work with Jan van Mill.

Alexander Dranishnikov *University of Florida at Gainesville, USA* Dimension theory approach to the Novikov Conjecture

abstract Asymptotic dimension $asdimX$ of a metric space X was introduced by Gromov as a concept which gives an invariant of finitely generated groups. Discrete groups here are considered as metric spaces taken with the word metric. This invariant proved to be useful for the Novikov Higher Signature conjecture. First, Gouliang Yu proved the (rational) Novikov Conjecture for groups Γ with $asdim\Gamma < \infty$. Later the integral Novikov Conjecture for asymptotically finite dimensional groups was proved independently by A. Bartels, Carlsson-Goldfarb (algebraic K-theory) and D-Ferry-Weinberger. Our approach uses the Higson compactification of groups.

E. Elfving *University of Helsinki* G-ANR's and G-CW complexes for proper actions of Lie groups.

abstract In [2] proper locally linear actions of Lie groups on topological manifolds were studied. Proper locally linear actions form a generalization of smooth proper actions. In the case of smooth proper actions of Lie groups it is known that every smooth proper G-manifold can be given an equivariant triangulation and hence in particular a G-CW complex structure, see [3].

In [2] the main theorem was

Theorem 1. Let G be a Lie group and M a proper locally linear G-manifold. Then M has the G-homotopy type of a G-CW complex.

In [1] we studied adjunction spaces and unions of G-ANE's for actions of a locally compact group G. We established equivariant versions of the Borsuk-Whitehead-Hanner theorem and of the Kodama theorem. As an application we proved that every proper G-CW complex is a G-ANE if G is a Lie group.

Our aim is to generalize the above mentioned Theorem 1 to arbitrary G-ANR's. This is joint work with S. Antonyan.

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Jerzy Dydak *University of Tennessee* Algebras derived from dimension theory

abstract The dimension algebra of graded groups is introduced. With the help of known geometric results of extension theory that algebra induces all known results of the cohomological dimension theory. Elements of the algebra are equivalence classes $\dim(A)$ of graded groups A. There are two geometric interpretations of those equivalence classes:
1. For pointed CW complexes K and L, $\dim(H_*(K)) = \dim(H_*(L))$ if and only if the infinite symmetric products $SP(K)$ and $SP(L)$ are of the same extension type (i.e., $SP(K) \in AE(X)$ iff $SP(L) \in AE(X)$ for all compact X).
2. For pointed compact spaces X and Y, $\dim(\mathcal{H}^{-*}(X)) = \dim(\mathcal{H}^{-*}(Y))$ if and only if X and Y are of the same dimension type (i.e., $\dim_G(X) = \dim_G(Y)$ for all Abelian groups G).

Dranishnikov's version of Hurewicz Theorem in extension theory becomes $\dim(\pi_*(K)) = \dim(H_*(K))$ for all simply connected K.

The concept of cohomological dimension $\dim_A(X)$ of a pointed compact space X with respect to a graded group A is introduced. It turns out $\dim_A(X) \leq 0$ iff $\dim_{A(n)}(X) \leq n$ for all $n \in Z$. If A and B are two positive graded groups, then $\dim(A) = \dim(B)$ if and only if $\dim_A(X) = \dim_B(X)$ for all compact X.

Hanspeter Fischer *Ball State University* Generalized universal covering spaces and the shape group

abstract It is known that if a topological space X admits a (classical) universal covering space, then the natural homomorphism $\varphi : \pi_1(X) \to \check{\pi}_1(X)$ from its fundamental group to its first shape homotopy group is an isomorphism. We present a partial converse: a path connected topological space X admits a *generalized* universal covering space if $\varphi : \pi_1(X) \to \check{\pi}_1(X)$ is injective. This generalized notion of universal covering $p : \tilde{X} \to X$ at which we arrive, enjoys most of the usual properties with the possible exception of evenly covered neighborhoods. It is universally characterized by the following three properties:

(1) $\tilde{X}$ is path connected, locally path connected and simply connected;
(2) $p : \tilde{X} \to X$ is a continuous surjection;
(3) for every continuous $f : (Y, y) \to (X, x)$, with Y path connected, locally path connected and simply connected, and for every $\tilde{x}$ in $\tilde{X}$ with $p(\tilde{x}) = x$, there exists a *unique* continuous lift $g : (Y, y) \to (\tilde{X}, \tilde{x})$ with $f = p \circ g$.

Additional properties of this generalized universal covering include:

(i) $\mathrm{Aut}(\tilde{X} \xrightarrow{p} X) \cong \pi_1(X)$;
(ii) $p : \tilde{X} \to X$ is open if and only if X is locally path connected;
(iii) if X is locally path connected and semilocally simply connected, then $p : \tilde{X} \to X$ agrees with the usual universal covering.

Spaces X for which $\varphi : \pi_1(X) \to \check{\pi}_1(X)$ is known to be injective include all subsets of the Euclidean plane, all 1-dimensional compacta, as well as boundaries of certain Coxeter groups.

Tetsuya Hosaka *Utsunomiya University, Japan* On splitting theorems for CAT(0) spaces

abstract In this talk, we introduce some splitting theorems for CAT(0) spaces and compact geodesic spaces of non-positive curvature. A *geometric* action on a CAT(0) space is an action by isometries which is proper and cocompact. We first proved the following splitting theorem which is an extension of a result in [1].

Theorem 1 Suppose that a group $\Gamma = \Gamma_1 \times \Gamma_2$ acts geometrically on a CAT(0) space X. If Γ_1 acts cocompactly on the convex hull $C(\Gamma_1 x_0)$ of some Γ_1-orbit, then there exists a closed, convex, Γ-invariant, quasi-dense subspace $X' \subset X$ such that X' splits as a product $X_1 \times X_2$ and there exist geometric actions of Γ_1 and Γ_2 on X_1 and X_2, respectively. Here each subspace of the form $X_1 \times \{x_2\}$ is the closed convex hull of some Γ_1-orbit.

Using this theorem, we showed some splitting theorems for CAT(0) spaces which are extensions of some results in [1]. As an application of these splitting theorems, we obtain the following theorem.

Theorem 2 Let Y be a compact geodesic space of non-positive curvature. Suppose that the fundamental group of Y splits as a product $\Gamma = \Gamma_1 \times \Gamma_2$ and that Γ has trivial center. Then there exists a deformation retract Y' of Y which splits as a product $Y_1 \times Y_2$ such that the fundamental group of Y_i is Γ_i for each $i = 1, 2$.

A CAT(0) group Γ is said to be *rigid*, if Γ determines the boundary up to homeomorphism of a CAT(0) space on which Γ acts geometrically. Then we denote $\partial\Gamma$ as the boundary of the rigid CAT(0) group Γ. Concerning rigidity of products of rigid CAT(0) groups, we obtained the following theorem.

Theorem 3 If Γ_1 and Γ_2 are rigid CAT(0) groups, then so is $\Gamma_1 \times \Gamma_2$, and the boundary $\partial(\Gamma_1 \times \Gamma_2)$ is homeomorphic to the join $\partial\Gamma_1 * \partial\Gamma_2$ of the boundaries of Γ_1 and Γ_2.

[1] M. R. Bridson and A. Haefliger, *Metric spaces of non-positive curvature*, Springer-Verlag, Berlin, 1999. [2] T. Hosaka, *On splitting theorems for CAT(0) spaces and compact geodesic spaces of non-positive curvature*, preprint.

Sören Illman *University of Helsinki* Hilbert's fifth problem and the very-strong C^∞ topology

abstract First we discuss Hilbert's fifth problem and then we go on to describe a technical point in the proof of the author's contribution to the fifth problem.

In his fifth problem Hilbert asks the following. Given a continuous action

$$\Phi\colon G \times M \to M$$

of a locally euclidean group G on a locally euclidean space M, can one choose coordinates in G and M so that the action Φ is real analytic?

In the special case when $G = M$ there is an affirmative answer. This is the celebrated result, due to Gleason, Montgomery and Zippin, which says that every locally euclidean group is a Lie group.

The answer to Hilbert's question in complete generality is no. However the following result was proved by the author.

Theorem. *Let G be a Lie group which acts on a smooth manifold M by a smooth proper action (in fact smooth Cartan action is enough). Then there exists a real analytic structure β on M, compatible with the given smooth structure on M, such that the action of G on M_β is real analytic.* Here smooth means C^∞ smooth, and the result is given in this form in [1]. The theorem also holds when smooth means

C^r smooth, $1 \leq r < \infty$, by essentially the same proof. It is in fact the proof in the C^∞ case that is more demanding, since it requires the use of the very-strong C^∞ topology, instead of the more common strong C^∞ topology.

In the C^∞ case the proof of the fact that the found real analytic structue β is compatible with the given smooth structure on M, makes use of the very-strong topology. It is in the following glueing lemma, where one glues together two C^∞ maps to obtain a C^∞ map, that one needs to use the very-strong C^∞ topology.

Lemma (see [2]). *Let $f\colon M \to N$ be a K-equivariant C^∞ map between C^∞ K-manifolds, where K is a compact Lie group. Then there exists an open neighborhood $\mathcal{N}$ of $f|U$ in $C^{\infty,K}_{vS}(U,N)$ such that the following holds: If $h \in \mathcal{N}$ and we define $E(h)\colon M \to N$ by*

$$E(h)(x) = \begin{cases} h(x), & x \in U \\ f(x), & x \in M - U, \end{cases}$$

then $E(h)$ is a K-equivariant C^∞ map. Furthermore $E\colon \mathcal{N} \to C^{\infty,K}_{vS}(M,N)$, $h \mapsto E(h)$, is continuous.

[1] S. Illman, *Every proper smooth action of a Lie group is equivalent to a real analytic action: a contribution to Hilbert's fifth problem*, Ann. Math. Stud. **138** (1995), 189–220.

[2] S. Illman, *The very-strong C^∞ topology on $C^\infty(M,N)$ and K-equivariant maps*, Osaka J. Math. **40** (2003), 409–428.

James Keesling *University of Florida* Inverse Limits of Tent Maps

abstract It has been a long-standing problem to classify the inverse limits of the form (I, f_s) where f_s is a member of the tent family, $f_s(x) = \min\{s \cdot x, s \cdot (1-x)\}$ $1 \leq s \leq 2$. Let f_s and f_t both be tent maps having turning point periodic. Lois Kailhofer has shown that in this case (I, f_s) is homeomorphic to (I, f_t) if and only if $s = t$.

In joint work with Louis Block, Slagjana Jakimovic, and Louis Kailhofer we have given a shorter proof of this result. The proof also shows that certain homeomorphisms are isotopic to a power of the shift map on the inverse limit space $\sigma^k_{f_s} : (I, f_s) \to (I, f_s)$ for some $k \in Z$. In particular, it is shown that if $h : (I, f_s) \to (I, f_s)$ is any homeomorphism, then for some $n = 0, 1, 2, \ldots$ h^n is isotopic to some $\sigma^k_{f_s}$. It is likely, but still remains open whether every homeomorphism h is isotopic to some $\sigma^k_{f_s}$.

The general inverse limit problem remains. It is conjectured that (I, f_s) being homeomorphic to (I, f_t) implies that $s = t$ without assuming that the turning points of f_s and f_t are periodic. The techniques developed in the new proof of Kailhofer's theorem suggest an approach to proving this general problem. We will discuss the progress being made in this direction.

Akira Koyama *Shizuoka University* Contractible polyhedra which are not embedded into the product of any graphs

abstract We have discussed several n-dimensional compacta which are not embedded into the product of any n 1-dimensional compacta. Then we represented criterions by words of cohomology groups. Thereby we did not use any geometric property and required relatively strong cohomological properties. Here we are discussing a class of manifold-like n-dimensional compacta which are not embedded into the product of any n 1-dimensional compacta. As its consequnece we show the

existence of 2-dimensional contractible polyhedra which are not embedded in the product of two any graphs.

References

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(ii) A. Koyama, J. Krasinkiewicz and S. Spież, On embeddings of compacta into products of curves, preprint.

F. William Lawvere *SUNY Buffalo* from bernoulli to Euler, guided by Volterra and Hurewicz

abstract A contravariant functor of structure (such as open or closed sets, continuous or smooth complex functions, etc.) is an important derived structure of categories $\mathcal{C}$ of cohesion (such as continuous, smooth, or combinatorial spaces). However, such cannot be the fundamental structure if $\mathcal{C}$ is to satisfy the elementary feature of general exponentiation, as required by Bernoulli and most later practitioners of the calculus of variations, made more explicit by Volterra and Hadamard. Bernoulli's principle that a functional $Y^X \to R$ is analytic (or continuous, or...) iff it is so when composed with any similar parameterized figure (curve, sequence, ...) permits reduction of the analysis to manageable types, namely to functions on $X \times P$ with P a parameterizer. Thus, as Hurewicz clarified with his definition of k-spaces, the basic structure of a suitable category needs to be a covariant one such as "P-shaped figures" $\mathcal{C}(\mathcal{P}, -)$ in order to achieve the needed exponential law. Of course, once geometric structure $\mathcal{C}(\mathcal{P}, -)$ has been specified for value spaces such as $R =$ Sierpinski space or $R =$ the complex plane, then derived algebraic structure can also be contravariantly defined for general spaces X in terms of P-natural maps $\mathcal{C}(\mathcal{P}, \mathcal{X}) \longrightarrow \mathcal{C}(\mathcal{P}, \mathcal{R})$. As in algebraic geometry, a small number of function-types R is often coadequate in a larger category of figure-types P which is in turn adequate for a whole exponentially-closed category. Euler's principle, that reals are ratios of infinitesimals, enables pushing this function/figure dialectic one step deeper if we explicitly exploit exponentials of infinitesimal spaces T; the spaces for which every connected component contains exactly one point include among their exponential spaces all R^n.

Fred E.J. Linton *Wesleyan University* An unnatural isomorphism for Real Banach spaces, and allied phenomena. *abstract* If we rotate the real plane about the origin by 45 degrees, and then dilate uniformly in all directions by a factor of $\sqrt{2}$, we realize a linear isometry between the plane with the l_1 norm and the plane with the sup norm. This observation, which is surely not new, seems to susceptible of virtually no generalization whatsoever: the talk will give details of an assortment of attractive-seeming generalization-candidates, and how they fail. One curious positive result comes up amidst the debris of failed candidates: yet another norm-characterization (surely also not new) of the 1-dimensional Banach space.

Luis Montejano *Instituto de Matemáticas. UNAM* Applications of topology to Discrete Geometry *abstract* We shall review our work in transversal Theory and Affine configurations of flats. In particual we shall considere the role of the topological ideas in these results.

Manuel Alonso Morón *Universidad Complutense de Madrid* Upper semifinite hyperspaces: A common framework for the computational and the topological treatment of attractors in flows

Abstract In this talk we show how to use the upper semifinite topology in the hyperspace of a compact metric space in oder to describe some shape properties and some fundamentals in computational topology used to study attractors in flows. In particular we study the concept of ε-connectedness used mainly by Vanessa Robins.

Seithuti P. Moshokoa *University of South Africa* Extensions of quasi-uniformly continuous maps

abstract We discuss the problem of extending a quasi-uniformly continuous map $f : (X, d) \to (Y, ||.||)$ from a quasi-pseudo metric space into a biBanach space to (X^*, e) a bicompletion of (X, d). We introduce a class of maps which preserves d^*-Cauchy sequences and present a result concerning extensions of these maps. Our result extends the Classical result concerning extensions of uniformly continuous maps between metric spaces.

Carlos Prieto *IMUNAM* Transfers for ramified coverings and equivariant homology and cohomology (jt. with M. Aguilar)

abstract We define a transfer in homology and cohomology for ramified covering maps and use it to prove some results on the homomorphisms induced by orbit maps of actions of finite groups.

Taras Radul *Universidad de los Andes, Colombia* On the transfinite extension of asymptotical inductive dimension

abstract Asymptotic dimension theory was founded by M.Gromov for studying invariants of discrete groups [1]. A.Dranishnikov has introduced the asymptotic inductive dimension $asInd$ [2]. M.Zarichnyi proposed consider the transfinite extension $trasInd$ of $asInd$ analogically to the transfinite extension of the usual inductive dimension. We prove that this extension is trivial, more exactly:

Theorem If there exists $trasIndX$ for some metric proper space X then $trasIndX < \omega$.

M.Gromov. Asymptotic Invariants of Infinite Groups, Geometric Group Theory. v.2. Cambrige Univ. Press, 199

A.Dranishnikov. On Asymptotic Inductive Dimension. JP Jour. Geometry and Topology, 2001, 1, 239–247.

Leonard R. Rubin *University of Oklahoma* Resolutions in Extension Theory

abstract The talk will deal with the theory of resolutions in extension theory. The first in this class of results was the Edwards-Walsh resolution theorem that was proved by John Walsh in 1981: If X is a metrizable compactum with $\dim_Z X \le n$, then there exist a metrizable compactum Z with $\dim Z \le n$ and a cell-like map π of Z onto X. This became an important step in A. Dranishnikov's affirmative answer to the Alexandroff question of whether a metrizable compactum simultaneously could be of infinite dimension and finite integral cohomological dimension.

After Walsh's publication, many other authors considered aspects of the question of resolutions, either in different classes of spaces, with respect to cohomological dimension for groups different from Z, or finally with respect to extension theory. Our presentation will attempt to trace these steps and at the end to indicate some of the most recent advances in this area.

Francisco R. Ruiz del Portal *Universidad Complutense de Madrid* A Poincaré formula for the fixed point index of homeomorphisms of surfaces

abstract Let $U \subset \mathbb{R}^2$ be an open subset and let $f : U \to \mathbb{R}^2$ be an arbitrary local homeomorphism such that $Fix(f^n) = \{p\}$ for every $n \in \mathbb{N}$. We compute geometrically the fixed point index of f^n at p, $i(f^n, p)$, in terms of the stable/unstable manifolds and the Leau-Fatou petals around p. We obtain in this way a sort of Poincaré formula without differentiability assumptions.

Jose M. R. Sanjurjo *Universidad Complutense (Madrid)* The Hopf bifurcation and shape theory

abstract The subject of the Hopf bifurcation had its origins in the work of Poincaré and since then it has been extensively studied by many authors, including Andronov. Hopf's fundamental contributions appeared in 1942. The Hopf bifurcation is originally related to the development of periodic orbits from a stable fixed point of a flow defined in the plane or in the Euclidean space. There is a richness of topological features in this theory making it specially suited to be studied with the techniques of geometric topology. We use, in particular, shape theory to study bifurcations of flows in manifolds and the global properties of some stable subsets which appear naturally in this context.

E.D.Tymchatyn *University of Saskatchewan* Simultaneous Extensions of Metrics

abstract by E.D.Tymchatyn and A.Zagorodnyuk We consider the problem of continuous simultaneous extension of partial (pseudo-)metrics on a metric space X. If X is also compact then such extensions exist (Tymchatyn-Zarichnyi,2004).

Theorem Let X be a metric space. There exists a continuous extension operator from the metric space of all Lipschitz equivalent partial pseudo-metrics on X to the space of all pseudo-metrics on X.

Alberto Verjovski *IMUNAM* On the moduli space of certain smooth codimension one foliations of the 5-sphere by complex surfaces

abstract In this talk, I will talk about recent joint work with Laurent Meersseman (Université de Rennes I).

I will first describe the set of all possible integrable CR-structures on the smooth foliation of $\mathbb{S}^{\ntrianglelefteq}$ constructed in [1]. I will give a specific concrete model of each of these structures. I wll show that this set can be naturally identified with $\mathbb{C}\times\mathbb{C}\times\mathbb{C}$. Adapting the classical notions of coarse and fine moduli space to the case of a foliation by complex manifolds, I will indicate the prooof that the previous set, identified with $\mathbb{C}^{\nVdash}$, defines a coarse moduli space for the foliation of [1], but that it does not have a fine moduli space. Finally, using the same ideas I will also indicate why the standard Lawson foliation on the 5-sphere can be endowed with CR-structures but none of these is integrable.

[1] L. Meersseman and A. Verjovsky. A smooth foliation of the 5-sphere by complex surfaces. Ann. of Math. 156 (2002), 915–930.

Tatsuhiko Yagasaki *Kyoto Institute of Technology* Homotopy types of spaces of embeddings of compact polyhedra into 2-manifolds

abstract The homotopy type of connected component of homeomorphism groups of connected 2-manifolds have been classified by M. E. Hamstrom, G. P. Scott et al. in the compact case and by the author in the noncompact case. In this talk we consider the problem of classifying the homotopy type of connected components of spaces of embeddings of compact connected polyhedra into 2-manifolds. Suppose M is a connected 2-manifold and X is a compact connected subpolyhedron of M with respect to some triangulation of M. Let $\mathcal{E}(X, M)$ denote the space of topological embeddings of X into M with the compact-open topology and let $\mathcal{E}(X, M)_0$ denote the connected component of the inclusion $i_X : X \subset M$ in $\mathcal{E}(X, M)$. We will describe the homotopy type of $\mathcal{E}(X, M)_0$ in terms of the subgroup $i_{X*}\pi_1(X) = \mathrm{Im}[i_{X*} : \pi_1(X) \to \pi_1(M)]$. If X is a point of M then $\mathcal{E}(X, M) \cong M$, and if X is a closed 2-manifold then $X = M$ and $\mathcal{E}(X, M)_0$ coincides with the identity component of homeomorphism groups of M. Below we assume that X *is neither a point nor a closed 2-manifold.*

Suppose $i_{X*}\pi_1(X)$ is not a cyclic subgroup of $\pi_1(M)$.

(1) $\mathcal{E}(X, M)_0 \simeq *$ *if* $M \not\cong \mathbb{T}^2, \mathbb{K}^2$.
(2) $\mathcal{E}(X, M)_0 \simeq \mathbb{T}^2$ *if* $M \cong \mathbb{T}^2$.
(3) $\mathcal{E}(X, M)_0 \simeq \mathbb{S}^1$ *if* $M \cong \mathbb{K}^2$.

Suppose $i_{X*}\pi_1(X)$ is a nontrivial cyclic subgroup of $\pi_1(M)$.

(1) $\mathcal{E}(X, M)_0 \simeq \mathbb{S}^1$ *if* $M \not\cong \mathbb{P}^2, \mathbb{T}^2, \mathbb{K}^2$.
(2) $\mathcal{E}(X, M)_0 \simeq \mathbb{T}^2$ *if* $M \cong \mathbb{T}^2$.
(3) Suppose $M \cong \mathbb{K}^2$.
  (i) $\mathcal{E}(X, M)_0 \simeq \mathbb{T}^2$ *if X is contained in an annulus which does not separate M.*
  (ii) $\mathcal{E}(X, M)_0 \simeq \mathbb{S}^1$ *otherwise.*
(4) Suppose $M \cong \mathbb{P}^2$.
  (i) $\mathcal{E}(X, M)_0 \simeq SO(3)/\mathbb{Z}_2$ *if X is an orientation reversing circle in M.*
  (ii) $\mathcal{E}(X, M)_0 \simeq SO(3)$ *otherwise.*

Here $\mathbb{S}^1$ is the circle, $\mathbb{T}^2$ is the torus, $\mathbb{P}^2$ is the projective plane and $\mathbb{K}^2$ is the Klein bottle. Finally consider the case where X is null homotopic in M. We choose a Riemannian manifold structure on M and denote by $S(TM)$ the unit circle bundle of the tangent bundle TM. When M is nonorientable, $\tilde{M}$ denotes the orientable double cover of M. *Suppose $i_{X*}\pi_1(X) = 1$ (i.e., $X \simeq *$ in M).*

(1) $\mathcal{E}(X, M)_0 \simeq S(TM)$ *if X is an arc or M is orientable.*
(2) $\mathcal{E}(X, M)_0 \simeq S(T\tilde{M})$ *if X is not an arc and M is nonorientable.*

Since $\mathcal{E}(X, M)$ is a topological ℓ^2-manifold, the topological type of $\mathcal{E}(X, M)_0$ is determined by the homotopy type of $\mathcal{E}(X, M)_0$.

4. Set-Theoretic Topology

Domingo Alcaraz Candela *Universidad Politécnica de Cartagena* Topological entropy for endommorphisms of totally bounded

abstract We analyze the relationship between the Bowen's entropy of a topological endomorphism α on a totally bounded (abelian) topological group G and the Bowen's entropy of its continuous extension to the Weil completion of G. The

infinitude of Bowen's entropy for group endomorphisms of totally bounded abelian groups is studied in the following two aspects:

(i) by providing a wealth of zero entropy endomorphisms whose extension to the completion of the group has infinite entropy;

(ii) by establishing smallness of the class $QfrakG$ of compact abelian groups without endomorphisms of infinite entropy.

J. Juan Angoa Amador *Facultad de Físico Matemáticas, BUAP* Spaces of continuous functions, Σ-products and box topology

abstract For a topological space X, we will denote by X_0 the set of its isolated points and X_1 will be equal to $X \setminus X_0 . C(X)$ denotes the space of real-valued continuous functions defined on X. $\Box\mathbb{R}^\kappa$ is the Cartesian product $\mathbb{R}^\kappa$ with its box topology, and $C_\Box(X)$ is $C(X)$ with the topology inherited from $\Box\mathbb{R}^\kappa$. By $\widehat{C}(X_1)$ we denote the set $\{f \in C(X_1) : f can be continuously extended to all of X\}$. A space X is almost-ω-resolvable if it can be partitioned by a countable family of subsets in such a way that every non-empty open subset of X has a non-empty intersection with the elements of an infinite subcollection of the given partition. We analyze $C_\Box(X)$ when X_0 is F_σ and prove: (1) for every T_1 topological space X, if X_0 is F_σ in X, and $\emptyset \neq X_1 \subset cl_X X_0$, then $C_\Box(X) \simeq \Box\mathbb{R}^{X_0}$; (2) for every Tychonoff space X such that X_0 is F_σ, $cl_X X_0 \cap X_1 \neq \emptyset$ and $X_1 \setminus cl_X X_0$ is almost-ω-resolvable, then $C_\Box(X)$ is homeomorphic to a free topological sum of $\geq |\widehat{C}(X_1)|$ copies of $\Box\mathbb{R}^{X_0}$, and, in this case, $C_\Box(X) \simeq \Box\mathbb{R}^{X_0}$ if and only if $|\widehat{C}(X_1)| \geq 2^{|X_0|}$. We also analyze $C_\Box(X)$ when $|X_1| = 1$ and when X is countably compact, and prove that the Σ-product $\Sigma_{\widehat{0}}\mathbb{R}^\kappa$ with the box product topology is not homeomorphic to $\Box\mathbb{R}^\delta$ for any δ when $cof(\delta) > \aleph_0$.

Liljana Babinkostova *Boise State University* Screenability and classical selection principles

abstract In this presentation we discuss the relationship between the selection principle $S_c(A, B)$ and the classical selection principles $S_{fin}(A, B)$ and $S_1(A, B)$.

Taras Banakh and Murat Tuncali *Ivan Franko Lviv National University and Nipissing University* Suslinian continua and "connected" versions of some classical topological cardinal invariants

abstract We introduce several cardinal invariants related to the Suslinian property of continua. Following A.Lelek we say that a continuum X is *Suslinian* if it contains no uncountable disjoint family of non-degenerated subcontinua. This property leads to the cardinal invariant $\bar{c}(X) = \sup\{|\mathcal{C}| : \mathcal{C}$ is a disjoint family of non-degenerate subcontinua in $X\}$ defined for any continuum X. The cardinal function $\bar{c}(\cdot)$ can be considered as a "connected" analogue of the cellularity where non-degenerate subcontinua paly the role of open sets. Following this ideology we can also introduce "connected" counterparts of other cardinal invarinats such as density, weight, π-weight. In particular, a "connected" analogue of the density is $\bar{d}(X) = \min\{|D| : D$ is a subset of X meeting each non-degenerate subcontinuum$\}$. The definitions of $\bar{c}(X)$ and $\bar{d}(X)$ can be extended to all Tychonov spaces X letting $\bar{c}(X) = \min\{\bar{c}(Y) : Y$ is a continuum containing $X\}$ and similarly for $\bar{d}(X)$. Unlike their classical originals, the cardinal functions $\bar{c}(\cdot)$ and $\bar{d}(\cdot)$ are monotone with respect to taking subspaces.

The main our result asserts that the weight $w(X)$ of any Tychonov space is $\leq \min\{\bar{d}(X), \bar{c}(X)^+\}$. Moreover, under the generalized Suslin Hypothesis, $w(X) \leq \bar{c}(X)$. Consequently each Suslinian continuum is hereditarily decomposable, has weight $\leq \aleph_1$ (and is metrizable if the Suslin Hypothesis holds). This answers one question of D.Daniel, J.Nikiel, L.B.Treybig, M.Tuncali and E.D.Tymchatyn. Each compact space X with $w(X) > \bar{c}(X)$ is the limit of an inverse well-ordered spectrum of length $\bar{c}(X)^+$ consisting of compacta with weight $\leq \bar{c}(X)$ and monotone bonding maps.

If X is a space with $\bar{c}(X) < 2^{\aleph_0}$, then rim-weight of X is $\leq \bar{c}(X)$ and $\bar{c}(X) \leq w(X) \leq \bar{c}(X)^+$. It is clear that $\bar{c}(X) \leq \bar{d}(X)$ for any space X and $\bar{c}(L) < \bar{d}(L)$ for a Suslin line L. On the other hand, we do not know if there is a metrizable continuum with $\bar{c}(X) < \bar{d}(X)$.

Jörg Brendle *The Graduate School of Science and Technology, Kobe University*
Measure and Category in Generalized Cantor Spaces

abstract For a cardinal λ, we consider the *generalized Cantor space* 2^λ equipped with the product topology and product measure as usual. Let M_λ denote the *meager ideal* on 2^λ and N_λ, the *null ideal* on 2^λ. Notice that every member of M_λ is contained in $A \in M_\lambda$ with countable support which means there are $\Lambda \in [\lambda]^{\aleph_0}$ and $A^* sub 2^\Lambda$ meager such that $A = \{x \in 2^\lambda : xre\Lambda \in A^*\}$. Thus M_λ and $M = M_{\aleph_0}$ are rather similar. An analogous comment applies to N_λ and $N = N_{\aleph_0}$. A number of people, including Cichoń, Fremlin, Kraszewski, and Miller, have investigated cardinal invariants related to the M_λ and the N_λ. For example, $add(M_\lambda) = \aleph_1$ and $cof(M_\lambda) = \max\{cof(M), cof([\lambda]^{\aleph_0})\}$ for $\lambda \geq \aleph_1$, $cov(M_\lambda)$ is decreasing in λ and stabilizes from some $\lambda < cc$ onwards. Similarly for N_λ.

Given a stationary set $S sub \omega_1$, $\clubsuit_S$ is the combinatorial principle asserting the existence of a sequence $la A_\alpha : \alpha \in S$ is a limit ordinal and A_α is cofinal in αra such that for all $A \in [\omega_1]^{\aleph_1}$ there is α with $A_\alpha sub A$. $\clubsuit$ abbreviates $\clubsuit_{\omega_1}$. $\clubsuit$ easily entails $cov(M_{\aleph_1}) = cov(N_{\aleph_1}) = \aleph_1$. Fuchino, Shelah, and Soukup proved the consistency of $\clubsuit$ with $cov(M) = cc \geq \aleph_2$. A fortiori, their model satisfies $cov(M) > cov(M_{\aleph_1})$. We subsequently obtained the analogous consistency result for the null ideal.

Recently we proved:

Theorem. It is consistent that $cov(M) = cc \geq \aleph_2$ and $\clubsuit_S$ holds for every stationary set S.

This extends the result of Fuchino, Shelah, and Soukup and answers a question of theirs.

Theorem The $cov(M_\lambda)$ may simultaneously assume any finite number of distinct values.

This answers a question of Kraszewski.

The purpose of our talk is

- to give an overview of results on cardinal invariants of the meager and null ideals on generalized Cantor spaces,
- to sketch proofs of Theorems 1 and 2 above, and
- to survey open problems in the area.

Dennis Burke *Miami University, Oxford, Ohio* Spaces with a sharp base

*abstract*Joint work with Zoltan Balogh.

The property of having a sharp base is not preserved under a perfect map.
Example. There exists a space X with a sharp base and a perfect mapping f :

$X \to Y$ onto a space Y which does not have a sharp base. It is known that a spaces with a sharp base have a point-countable sharp base. This can be sharpened to "point-finite" on the set of isolated points. **Theorem.** If X has a sharp base then X has a point-countable sharp base which is point-finite on the set H of isolated points. (Hence H is an F_σ set.) This theorem follows from a more general combinatorial argument about certain $\{0,1\}$ matrices on $\kappa \times \kappa$.

Agustín Contreras Carreto *Facultad de Ciencias Físico-Matemáticas de la BUAP* Some properties of cardinal functions wl, qwl, aql, ac, lc and ql

abstract One of the known equalities is the Bell-Ginsburg-Woods's inequality: if X is a T_4-space, then $|X| \leq 2^{wl(X)\chi(X)}$. In this talk we are going to introduce the cardinal function qwl, wich satisfices $qwl(X) \leq wl(X)$, for every topological space; and we will to establish the following most general result:if X is a T_4-space, then $|X| \leq 2^{qwl(X)\chi(X)}$. Later we give an example to shows that the our result can give better estiamtion than one of Bell-Ginsburg-Woods's inequality. Moreover we will present some reflection properties for cardinal functions wl, qwl, aql, ac, lc and ql.

Dikran Dikranjan *Udine University* Separation via sequential limit laws in topological groups

abstract Let (u_n) be a sequence of integers. We say that an element x of a topological group G satisfies the *sequential limit law* (SLL, in brief) (u_n), if the powers x^{u_n} tend to e_G.

Motivated by the definition of T_0 and T_1 separation axioms for topological spaces and replacing points x by cyclic subgroups $\langle x\rangle$, we propse separation axioms $\mathcal{G}_0$, $\mathcal{G}_1$ and $\mathcal{G}_2$ for a topological group X as follows:

(a) X is $\mathcal{G}_0$, if for distinct $\langle x\rangle$ and $\langle y\rangle$ in X there exists a SLL (u_n) such that either x satisfies (u_n) while y does not satisfy (u_n), or y satisfies (u_n) while x does not satisfy (u_n);

(b) X is $\mathcal{G}_1$, if for every y in X that does not belong to $\langle x\rangle$ there exists a SLL (u_n) such that x satisfies (u_n) while y does not satisfy (u_n);

(c) X is $\mathcal{G}_2$, if for every x in X there exists a SLL (u_n) such that x satisfies (u_n), while no y that does not belong to $\langle x\rangle$ satisfies (u_n).

Replacing the sequence of integers (u_n) by a sequence of characters of X and asking convergence of $u_n(x)$ to 1 in the circle group $\mathbf{T}$ instead of the above defined SLL (u_n), one can define similarly separation axioms $\mathcal{S}_0$, $\mathcal{S}_1$ and $\mathcal{S}_2$ for a topological group X. Then:

1. $\mathcal{G}_0$, $\mathcal{G}_1$ and $\mathcal{G}_2$ coincide for any non-discrete locally compact group X and are equivalent to X being isomorphic to $\mathbf{T}$.
2. $\mathcal{S}_0$ and $\mathcal{S}_1$ coincide for any topological abelian group X and are equivalent to X being maximally almost periodic.
3. A topological abelian group X satisfies $\mathcal{S}_2$ iff its Bohr topology has countable pseudocharacter.

Szymon Dolecki *Mathematical Institue of Burgundy* Combinatorics in convergence theory

abstract Examples of combinatorial problems arising in topology and convergence theory will be presented. Estimates of sequential order of finite products of sequential topologies in terms of nodalities lead to certain transfinite combinatorial

problems [1]. Study of irregularity numbers of pretopologies leads to combinatorics of subintervals of some trees [2].

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Stefano Ferri *Universidad de los Andes, Bogotá, Colombia.* Continuity in Topological Groups

abstract A topological group is a group equipped with a (Hausdorff) topology such that both multiplication and inversion are continuous mappings. However, in certain cases one can deduce that a group G with a topology is a topological group under less restrictive assumptions. For example if G is a Baire metrizable space one can deduce that G is a topological group under the only assuption that multiplication is a separately continuous mapping. In this talk we consider a group G equipped with a Baire metrizable topology and prove that, under these assumptions, if right translations are continuous and left translations are almost-continuous, then G is a topological group. This is joint work with Salvador Hernández Muñoz and Ta-Sun Wu.

Adalberto García Maynez *Instituto de Matemáticas, UNAM, México* Upper bounds for uniform weights

abstract Consider a Tychonoff space $(X,\mathcal{T})$ and a compatible uniformity $\mathcal{U}$ on X. We denote by $\omega(X,\mathcal{U})$ the minimum possible cardinality of a basis of $\mathcal{U}$. If $(X,\mathcal{T})$ is not a discrete space, we know $\aleph_0 \leq \omega(X,\mathcal{U})$ and $\aleph_0 = \omega(X,\mathcal{U})$ implies that X is metrizable. We prove that always $\omega(X,\mathcal{U}) \leq z(X \times X)$, where for every space Y, $z(Y)$ denotes the cardinality of the family of zero subsets of Y. If $\mathcal{U}$ is totally bounded, we have a better upper bound, namely $\omega(X,\mathcal{U}) \leq z(X)$. If $\mathcal{U}_n$ is the fine uniformity of $(X,\mathcal{T})$, we know that $\omega(X,\mathcal{U}_n) \leq \aleph_0$ if and only if the space X is metrizable and the set of limit points X^a is compact. Is it true that $\omega(X,\mathcal{U}) \leq z(X)$? this may be a forcing problem. If δX is the density of X, we know $\delta X \leq z(X) \leq z(X \times X) \leq 2^{\delta X}$, so if we assume the GCH, δX and $2^{\delta X}$ are the only possible values of $z(X)$ and $z(X \times X)$. The task is very clear although it might be very difficult) : Using the example in ZFC of a Tychonoff space X such that $z(X) < z(X \times X)$, calculate $\omega(X,\mathcal{U})$. The talk will concentrate on the methods to obtain upper bounds for uniform weights.

Chris Good *University of Birmingham, UK* Inhomogeneities in inverse limits of tent maps.

Gary Gruenhage *Auburn University* Paracompact ordered spaces are base-paracompact

abstract J.E. Porter defined a space X to be base-paracompact if X has a base B of cardinality the weight of X such that every open cover of X has a locally finite refinement by members of B. He proved that paracompact ordered spaces of weight $\aleph_1$ (or less) are base-paracompact, and asked if all paracompact ordered spaces are base-paracompact. We show that they are. We should remark that Porter also asked whether every paracompact space is base-paracompact; this is still unsolved.

Yasunao Hattori *Shimane University, Japan* On representations of spaces by unions of locally compact subspaces

abstract Vitalij A.Chatyrko, Yasunao Hattori and Haruto Ohta In this talk, we shall discuss the possibility of different presentations of (locally compact) spaces as unions or disjoint unions of locally compact subspaces. We begin with an observation of locally closed sets. A subset A of a space X is called a *locally closed* (we say here a G_{co}*-set in* X) if there are a closed subset F and an open subset O of X such that $A = F \cap O$. Furthermore, we put $G_{co}(X) = \{A : A \text{ is a } G_{co}\text{-set in X }\}$.

Proposition. *For every space X, $G_{co}(X)$ is a semiring.*

Corollary. *Let $A = \cup_{i=1}^{n} A_i$, where $A_i \in G_{co}(X)$ for every $i = 1, 2, \ldots, n$.*

(1) *There are finitely many disjoint sets $B_1, ..., B_t \in G_{co}(X)$ such that $A = \cup_{i=1}^{t} B_i$ and for every i, there is $M_i \subset \{1, \ldots, t\}$ such that $A_i = \cup\{B_s : s \in M_i\}$.*

(2) *There are finitely many disjoint sets $C_1, ..., C_l \in G_{co}(X)$ such that $X \setminus A = \cup_{i=1}^{l} C_i$.*

Now, we define cardinal numbers $lc(X)$ and $lcd(X)$ for a space X as follows: $lc(d)(X) = \min\{\tau : X \text{ has a cover (partition) } \{L_t : t \in B\}$ of locally compact subspaces of X such that card $(B) = \tau\}$. Evidently, the inequalities $lc(X) \leq lcd(X) \leq \text{card}(X)$ hold for every space X. Then we have the following.

Example. For every natural number $i = 1, 2, \ldots$ there is a countable discrete subspace (and hence locally compact subspace) X_i of the closed interval $\mathbb{I} = [0, 1]$ such that

(1) $X_i \cap X_j = \emptyset$ if $i \neq j$,

(2) $lc(A_n) = lcd(A_n) = n$, for each $n \geq 2$, where $A_n = \cup_{i=1}^{n} X_i$,

(3) $lc(\mathbb{I} - A_n) = lcd(\mathbb{I} - A_n) = n$, for each $n \geq 2$.

Concerning the relationship between lc and lcd, we have

Theorem 1. *Let X be a Hausdorff space with $lc(X) \leq \aleph_0$, then $lc(X) = lcd(X)$ holds.*

As an application of the corollary above to dimension theory, we have the following.

Theorem 2. *Let X be a perfectly normal space.*

(1) *If $X = (\cup_{i=1}^{n} A_i) \cup B$, where $A_i \in G_{co}(X)$ (in particular, if A_i is a locally compact subspace of X) for every i, then* $\dim X = \max\{\dim A_i, i = 1, ..., n, \dim B\}$.

(2) *If X is paracompact and $X = (\cup \nu) \cup B$, where $\nu = \{A_s : s \in S\}$ is a locally finite system of G_{co}-sets in X (locally compact subspaces of X) then* $\dim X = \max\{\dim A_s, s \in S, \dim B\}$.

Melvin Henriksen *Harvey Mudd College* One point metric completions

abstract If a metrizable space X is a dense in a metrizable space Y, then Y is called a metric extension of X. If T1 and T2 are metric extensions of X and there is a continuous map of T2 into T1 that keeping X pointwise fixed, we write T1<=T2. If X is noncompact and metrizable, then (M(X),<=) denotes the set of metric extensions of X, where T1 and T2are identified if T1<=T2 and T2<=T1, i.e., if there is a homeomorphism of T1 onto T2 keeping X pointwise fixed. (M(X),<=) is a large complicated poset studied extensively by V. Bel'nov [The structure of the set of metric extensions of a noncompact metrizable space, Trans. Moscow Math. Soc. 32 (1975), 1-30]. We study the poset (E(X),<=) of one-point metric extensions of a locally compact metrizable space X. Each such extension is a (Cauchy) completion of X with respect to a compatible metric. This poset resembles the lattice of compactifications of locally compact space if X is also separable. For Tychonoff

X , let X*= X X, and let Z(X) be the poset of zerosets of X partially ordered by set inclusion. Theorem If X and Y are locally compact separable metrizable spaces, then (E(X),<=) and (E(Y),<=) are order-isomorphic iff Z(X*) and Z(Y*) are order isomorphic, and iff X* and Y* are homeomorphic. We construct an order preserving bijection lamda E(X)−− >Z(X*) such that a one-point completion in E(X) is locally compact iff its image under lamda is clopen. We extend some results to the nonseparable case, but leave problems open. This is part of joint research with L. Janos and R.G. Woods that will appear in C.M.U.C.

Fernando Hernández-Hernández *IM-UNAM (Morelia)* Realcompactness on Psi-spaces

abstract I will discuss some conditions on the almost disjoint family $CalA$ to get realcompactness of $\Psi(CalA)$ and some realted problems.

Heikki Junnila *University of Helsinki* Hereditary covering properties of weak*-topologies

abstract We characterize several well-established properties (such as having an equivalent *uniformly Gateaux smooth* norm or being *weakly countably determined*) of Banach spaces in terms of hereditary covering properties (such as hereditary *bounded σ-metacompactness* or hereditary *σ- distributive metacompacteness*) of the weak*-topologies of the dual spaces.

Masaru Kada *Advanced Research Institute for Science and Engineering, Waseda University* How many miles to βX?

abstract Joint work with Kazuo Tomoyasu and Yasuo Yoshinobu. It is known that the Stone–Čech compactification βX of a metrizable space X is approximated by the collection of Smirnov compactifications of X for all compatible metrics on X [Woods, 1995]. If we confine ourselves to locally compact separable metrizable spaces, the corresponding theorem holds for Higson compactifications [Kawamura-Tomoyasu, 2001]. So how many compatible metrics do we actually need to approximate βX by Smirnov or Higson compactifications of X? Let $sa(X)$ denote the smallest cardinality of a set D of compatible metrics on X such that βX is approximated by Smirnov compactifications for all metrics in D, and $ha(X)$ the corresponding cardinal for Higson compactifications. We present the following results. (1) For a locally compact separable metrizable space X, $sa(X) = ha(X) = d$ (the dominating number) if the set of nonisolated points of X is noncompact, and otherwise $sa(X) = ha(X) = 1$. In particular, $ha(X)$ is either d or 1 while it is defined. (2) There is a metrizable space X for which $sa(X) > d$. This theorem leads $sa(\omega) = ha(\omega) = 1$. To investigate the case of ω further, we consider the following cardinals. Let sp be the the smallest cardinality of a set D of compatible metrics on ω such that, $\beta\omega$ is approximated by Smirnov compactifications for all metrics in D but any finite subset of D does not suffice, and hp the corresponding cardinal for Higson compactifications. We will present ZFC-results and consistency results on the relationship among sp, hp and other known cardinal invariants of the reals.

Martin Maria Kovar *University of Technology, Brno* Maximal compact topologies in the light of the de Groot dual

abstract Using some advanced properties of the de Groot dual and a modified Hofmann-Mislove theorem, we will present a positive solution of an old question of D. E. Cameron (1977): Is every compact topology contained in some maximal compact topology? The solution is based on a construction of a maximal ring of sets, containing the closed sets of the given compact space, which is contained in the family of the compact sets. If the given space is sober T_1, then one can obtain directly the requested maximal compact topology which is generated by the ring (Kunzi + Zyphen, 2003). However, for a general space we need the de Groot dual of the ring, too. The topology generated by the maximal ring of sets need not be compact in general, but luckily, its dual is always compact. And even more luckily, between this topology and its de Groot dual there always exists a maximal compact topology The only remaining problem is, how one can get the original topology below that maximal compact topology. To do it, we will use a modified Hofmann-Milsove theorem with some additional tricks, which allow us to finish and solve the puzzle.

Justin Tatch Moore *Boise State University* Counterexamples to basis problems in set theory and topology

abstract I will present the following ZFC result.

Theorem: There is a hereditarily Lindelöf, non-separable space.

One immediate consequence is that the uncountable regular topological spaces do not have a three element basis. The combinatorial object which makes the construction work also gives a number of other examples. In particular it produces a binary relation R which is neither below $\omega \cdot \omega_1$ nor above $[\omega_1]^{<\omega}$ in the Tukey order. It also gives an example of a function c from $\omega_1 \times \omega_1$ to ω_1 which takes all values on any product of uncountable sets.

Peter Nyikos *University of South Carolina* Recent research on the compact-open topology and modifications

abstract Let $C_k(X)$ stand for the space of continuous functions from X to $\mathbb{R}$ with the compact-open topology. For compact K, $C_k(K)$ is simply the Banach space given by the sup norm, but when X is not locally compact, $C_k(X)$ is very complicated. Gartside and Reznichenko showed that $C_k(X)$ is stratifiable whenever X is a Polish space; as a result, $C_k(\mathbb{P})$ has emerged as a prime candidate for a negative solution to the 43-year-old problem of whether every stratifiable space is M_1. The following problem is also of interest: Problem 1 Let X be separable metrizable. If $C_k(X)$ is stratifiable, must X be completely metrizable?

The converse is true. Problem 1 easily reduces to the 0-dimensional case. Since every scattered metrizable space is completely metrizable, the only restriction on the following partial solution to Problem 1 is in the last clause in the hypothesis.

Theorem 1 Let X be a 0-dimensional separable metrizable space which is not scattered, and has the property that every compact subset is countable. Then $C_k(X)$ is not stratifiable.

This result is new even in the special case $X = \mathbb{Q}$, answering a question posed by Gary Gruenhage at the 2003 Lubbock conference. Theorem 1 made use of the following elegant criterion in.

Theorem Let X be a 0-dimensional separable metrizable space. Then $C_k(X)$ is stratifiable if, and only if, it is possible to assign to each clopen subset W of X a compact $F(W) \subset W$, and to each compact $K \subset X$ a compact $\phi(K) \supset K$ in such a way that, whenever $W \cap K \neq \emptyset$, it follows that $F(W) \cap \phi(K) \neq \emptyset$ also.

This theorem also figures in the proof of Theorem 2 below, which represents the first progress towards the solution of the following problem. Problem 2 Let $C_s(\mathbb{P},\omega)$ stand for the set of continuous natural-number-valued functions on $\mathbb{P}$ with the sequential modification of the compact-open topology. Is $C_s(\mathbb{P},\omega)$ 0-dimensional? The modification in question is the one in which a set is open iff it is sequentially open in $C_k(\mathbb{P},\omega)$. Sequential convergence in $C_k(\mathbb{P},\omega)$ has the following appealing characterization:

$$f_n \to f \iff f_n(x_n) \to f(x) \text{ whenever } x_i \to x.$$

A positive solution to Problem 2 would be enough to solve a problem in theoretical computer science. This problem is whether two competing approaches to higher-type real-number computability actually coincide on level 3. References , and explain these concepts, and shows how analogues of Problem 2, obtained by iterating the functor $C_s(\cdot,\omega)$, would establish the coincidence at all levels. Definition A space X is semiregular if it has a base of regular open sets, and countably 0-dimensional if whenever $x \in X$ and F is a countable closed subset of X, then there is a clopen set containing x and missing F.

Theorem 2 $C_s(\mathbb{P},\omega)$ is semiregular and countably 0-dimensional. In fact, if $x \in C_s(\mathbb{P},\omega) \setminus F$ and F is a countable closed subset of $C_s(\mathbb{P},\omega)$, then there is a set U that is open in $C_p(\mathbb{P},\omega)$ and closed in $C_s(\mathbb{P},\omega)$, contains F, and misses x.

Here C_p refers to the product topology, which is much coarser than the compact-open topology in this context.

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Oleg Pavlov *Towson University* A zero-dimensional homogenous space with the fixed-point property

abstract Jan van Mill asked at the 2004 Spring Topology Conference whether there exists a nontrivial zero-dimensional homogenous space with the fixed-point property for homeomorphisms. We answer this question affirmatively.

Robert Raphael *Concordia University* The Epimorphic problem for C(X).

abstract We recall that epimorphisms need not be surjective in the category of commutative rings. Assume all spaces Tychonoff. Call a space X absolutely CR-epic if whenever X is a subspace of Y the induced ring homomorphism from C(Y) to C(X) is a ring epimorphism.

Our goal is characterize absolutely CR-epic spaces. There is an easy description of these spaces in the Lindelof case. There are complete results in the first countable

case, and there are nuanced countable examples in the presence of the continuum hypothesis.

The work is joint. The most recent paper is with Barr and Kennison.

Ivan L Reilly *University of Auckland* Generalized closed sets

abstract This talk will discuss generalized closed sets (in the sense of Norman Levine) and their developments. It will consider their use in characterizing low separation properties, extremally disconnected spaces and variations of submaximal spaces. It represents joint work with J. Cao, M. Ganster, S. Greenwood and Ch. Konstadilaki.

Ennis Rosas *Universidad de Oriente-Nucleo de Sucre- Venezuela* (α, β) Contra Continuous Functions and (α, β) Contra Irresolute Functions

abstract

Masami Sakai *Kanagawa University* On κ-Fréchet Urysohn property in $C_p(X)$

abstract A space X is said to be κ-Fréchet Urysohn if for every open U of X and any point x in the closure of U, there exists a sequence in U which converges to x. This notion was introduced by Arhangel'skii. We give a characterization of κ-Fréchet Urysohn property in $C_p(X)$. The characterization introduce a special subset of the real line.

A.A. Salama *egypt* FUZZY -CONTINUITY AND

abstract In this paper, we study the concepts of fuzzy -open sets, fuzzy -closed sets. By using these concepts, we introduce and study the concept of fuzzy -continuity and -compactness in fuzzy topological spaces. In section 1, we study the concepts of fuzzy -open sets and fuzzy -closed sets in the light of quasi-coincident notion. In section 2 we study some properties of -continuous function and Urysohn space in fuzzy setting. In secton3, we introduce the concept of -compactness in fuzzy setting. Also, we give a characterizations and properties of -compactness in the light of the concept of -shading. A characterization of -compactness is given by using the concept of -finite intersection property due to [3]. Also, we show that in a fuzzy extremally disconnected space the concepts of -compactness, -compactness and -near compactness are equivalent. We investigate the image and the inverse image of -compactness under some types of functions. Finally, we define a locally -compactness in fuzzy setting and give some results on it.

Manuel Sanchis *Universitat Jaume I de Castell (Spain)* Some Solved and some Unsolved Problems in Linearly Ordered Dynamical Systems

abstract A (discrete) dynamical system (X, f) is said to be *linearly ordered* (in short, *LODS*) if the phase space X is a topological linearly ordered space. The main purpose of this note is to presente what is known and what is unknown (so far the author knows) in the realm of this kind of dynamical systems. The study of *LODS* was starting by Schimer in [5] who showed that every connected *LODS* satisfies the *right part* of the classical Šarkovskiĭ's Theorem about the structure of the periodic points and asking if the *left part* is also valid. This question was answered in the negative by Baldwin [2] by proving that there is three class of connected linearly ordered spaces related with Šarkovskiĭ's Theorem (the so-called Baldwin's classification): (1) spaces satisfying Šarkovskiĭ's Theorem, (2) spaces with no continuous functions having periodic points of period not a power of 2, and

(3) spaces with no continuous functions having periodic points of period not a power of 2, or any power of two higher than n for some $n \geq 0$. Baldwin's classification arises the question of finding dynamical properties characterizing spaces (1), (2) and (3). For spaces (1), a characterization is obtained in [1] by means of the concept of turbulent functions. For spaces (2) and (3), the question remains open. Another way of research in $LODS$ was begun in [1]: the study of minimal sets. For a dynamical system (X, f), recall that a subset $M \subseteq X$ is said to be a *minimal set for* f if it is nonempty, closed and invariant, and if no proper subset of M has these three properties. It is apparent that a finite subset is minimal if and only if it is a periodic orbit. However, identifying infinite minimal sets may be an arduous work (and in many occurrences, it is an open question). A well-known result in one dimensional dynamics characterizes infinite minimal sets (see e.g. [3]) by means of Cantor sets. Actually, every infinite minimal set for a function on the interval $\mathbb{I}$ is a Cantor set and, conversely, given a Cantor subset C of $\mathbb{I}$, there exists $f \in C(\mathbb{I}, \mathbb{I})$ such that C is a minimal set for f. This elegant and powerful result arises question of characterizing minimal sets in a continuum $LODS$, that is in a $LODS$ whose phase space is both compact and connected (recall that a separable continuum linearly ordered space is linearly isomorphic to the interval). The first result in this field was obtained in [1]: every infinite minimal set in a continuum $LODS$ enjoys the same properties as a Cantor set except that it can fail to be metrizable. Moreover, it is also shown that it is not possible to obtain a result similar to the one in the case of the interval: there exist linearly ordered continua where the minimal set are exactly the periodic orbits. In spite of the previous results, no examples of such subsets have been known. To finish we present the construction (in ZFC) presented in [4] of $2^{\mathfrak{c}}$ non-homeomorphic, non-metrizable infinite minimal sets on a continuum $LODS$ of cardinality $2^{\mathfrak{c}}$. Some open question related to minimality on $LODS$ are also commented.

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Marion Scheepers *Boise State University* Selection principles in topological groups

abstract We discuss classical selection principles in the context of topological groups.

Paul J. Szeptycki *York University* Products of ordinals and *sigma*-products

abstract I will give a short survey of properties of products of ordinals and some natural subspaces, focussing on σ-products. It was proved by the author and N. Kemoto that if X is a *sigma*-product or Σ-product of ordinals at base point 0, then X is strongly zero-dimensional, countably paracompact et al. If the

base point is different from 0, these properties may fail. In particular, countable paracompactness of a σ-product depends on the choice of the base point.

Angel Tamariz Mascarúa *Facultad de Ciencias, UNAM* Spaces of Continuous Functions Defined on Mrwka Spaces

abstract Joint work with M. Hruzăk and P.J. Szeptycki.

We prove that for a maximal almost disjoint family $\mathcal{A}$ on ω, the space $C_p(\Psi(\mathcal{A}), 2^\omega)$ of continuous Cantor-valued functions with the pointwise convergence topology defined on the Mrówka space $\Psi(\mathcal{A})$ is not normal. Using CH we construct a maximal almost disjoint family $\mathcal{A}$ for which the space $C_p(\Psi(\mathcal{A}), 2)$ of continuous $\{0,1\}$-valued functions defined on $\Psi(\mathcal{A})$ is Lindelöf. These theorems improve some results due to A. Dow and P. Simon in [DS]. We also prove that this space $C_p(\Psi(\mathcal{A}), 2) = X$ is a Michael space; that is, X^n is Lindelöf for every $n \in \mathbb{N}$ and neither X^ω nor $X \times \omega^\omega$ are normal.

Moreover, we prove that for every uncountable almost disjoint family $\mathcal{A}$ on ω and every compactification $b\Psi(\mathcal{A})$ of $\Psi(\mathcal{A})$, the space $C_p(b\Psi(\mathcal{A}), 2^\omega)$ is not normal.

Mikhail Tkachenko *Universidad Autónoma Metropolitana* Independent, transversal, and T_1-complementary topologies

*abstract*All topologies we consider are assumed to satisfy the T_1 separation axiom. Two topologies τ_1 and τ_2 on a set X are said to be *T_1-independent* if the intersection $\tau_1 \cap \tau_2$ is the cofinite topology on X. A pair τ_1, τ_2 of T_1-independent topologies on an infinite set has to have very special properties. For example, if both τ_1 and τ_2 are Hausdorff and the first topology is sequential, then the second one is countably compact and does not contain non-trivial convergent sequences. One can construct, under Martin's Axiom, a Hausdorff topological group topology $\mathcal{T}$ on the group of reals R such that $\mathcal{T}$ is T_1-independent of the usual interval topology τ on R (see [3]). Clearly, the topology $\mathcal{T}$ is countably compact and all compact subsets of the group $(R, \mathcal{T}))$ are finite. Topologies τ_1 and τ_2 on a set X are called *transversal* provided that the join $\tau_1 \vee \tau_2$ of τ_1 and τ_2 is the discrete topology of X. In other words, for every point $x \in X$ there are sets $U_1 \in \tau_1$ and $U_2 \in \tau_2$ such that $U_1 \cap U_2 = \{x\}$. Transversal topologies are abundant: if a topology τ_1 contains two disjoint non-empty open sets, then it admits a transversal compact Hausdorff topology [2]. In particular, every Hausdorff topology admits a transversal compact Hausdorff topology. If topologies τ_1 and τ_2 on a set X are T_1-independent and transversal, they are called *T_1-complementary.* Furthermore, if there exists a bijection f of X onto itself such that $\tau_2 = \{f(U) : U \in \tau_1\}$, then the topology τ_1 is said to be *self T_1-complementary.* It is not easy at all to construct a completely regular self T_1-complementary topology on an infinite set, the first construction of such a topology was given by S. Watson [4]. Quite recently, Shakhmatov and the author succeded in constructing a compact Hausdorff space which is a T_1-complement of itself [1]. In the talk we will present a survey of results concerning T_1-independent, transversal and T_1-complementary topologies and formulate a number of open problems in this area.

[1] D. Shakhmatov and M. Tkachenko, A compact Hausdorff topology that is T_1-complement of itself, *Fund. Math.* **175** (2002), 163–173.

[2] D. Shakhmatov, M. Tkachenko, and R. Wilson, Transversal and T_1-independent topologies, *Houston J. Math.* **30** no. 2 (2004), 421–433.

[3] M. G. Tkachenko and Iv. Yaschenko, Independent group topologies on Abelian groups, *Topology Appl.* **122** (2002) no. 1-2, 425–451.

[4] W. S. Watson, A completely regular space which is the T_1-complement of itself, *Proc. Amer. Math. Soc.* **124** (1996), no. 4, 1281–1284.

Vladimir Tkachuk *Universidad Autonoma Metropolitana de Mexico* Domination by the irrationals and K-analyticity.

abstract We consider the irrationals to be the space ω^ω; given $p, q \in \omega^\omega$ let $p \leq q$ if $p(n) \leq q(n)$ for all $n \in \omega$. A space X is *dominated by the irrationals* if there exists a compact cover $\{K_p : p \in \omega^\omega\}$ of the space X such that $p \leq q$ implies $K_p \subset K_q$. The space X is said to be *strongly dominated by the irrationals* if if there exists a compact cover $\{K_p : p \in \omega^\omega\}$ of the space X such that $p \leq q$ implies $K_p \subset K_q$ and, for any compact $K \subset X$ there is $p \in \omega^\omega$ such that $K \subset K_p$. Every K-analytic space is dominated by the irrationals; since the converse of this statement does not hold, it is a natural question when the domination with the irrationals coincides with K-analyticity. We prove that, for any space X, the space $C_p(X)$ is dominated by the irrationals if and only if it is K-analytic. The importance of strong domination by the irrationals stems from the fact that this concept generalizes hemicompactness; besides, a second countable space is strongly dominated by the irrationals if and only if it is completely metrizable. We show that it is independent of ZFC whether ω_1 is strongly dominated by the irrationals. We prove, among other things, that a space $C_p(X)$ is strongly dominated by the irrationals if and only if X is countable and discrete.

Artur Hideyuki Tomita *Sau Paublo University* A solution to Comforts question on the countable compactness of powers of a topological group.

abstract Comfort and Ross (Pacific J., 1966) showed that pseudocompactness is productive in the class of topological groups. E. van Douwen (Trans. AMS, 1980)showed that Martins Axiom imply that there exists two countably compact groups whose square is not countably compact. Hart and van Mill (Trans. AMS, 1991)showed that under Martins Axiom for countable posets, there exists a countably compact group whose square is not countably compact. Garcia-Ferreira, Tomita and Watson (Proc. AMS, to appear) showed that the existence of a selective ultrafilter implies the existence of two countably compact groups whose product is not countably compact. Recently, Tomita showed that from the existence of a selective ultrafilter, there exists a countably compact group whose square is not countably compact. Scarborough and Stone (Trans. AMS, 1966) showed that the product of a family of countably compact spaces is

countably compact if every product of a subfamily of size at most $2^{2^{\mathfrak{c}}}$ is countably compact. Ginsburg and Saks (Pacific J., 1975) showed that it suffices to consider subfamilies of size at most $2^{2^{\omega}}$. The example of Hart and van Mill and the result of Ginsburg and Saks motivated Comfort (Open Problems is Topology, Question 477) to ask the following;

Is there, for every (not necessarily infinite) cardinal $\alpha \leq 2^{\mathfrak{c}}$, a topological group G such that G^γ is countably compact for all cardinals $\gamma < \alpha$ but G^α is not countably compact?

Using Martin's Axiom for countable posets, it was shown that 2 (Hart and van Mill, op. cit.), some $k \in [n+1, 2^n]$ for each $n \in \omega$ (1996, Tomita, CMUC), 3 (Tomita, Topology Appl., 1999) and every positive integer (Tomita, Topology

Appl., to appear) are such cardinals. However, Comfort's Question remained open for infinite cardinals.

Garcia-Ferreira and Tomita (Bol. Soc. Mex. Mat., 2003) showed via forcing there exists a family of topological groups $\{G_\xi : \xi < 2^{\mathfrak{c}}\}$ such that for each $I \subseteq 2^{\mathfrak{c}}$, $\prod_{\xi \in I} G_\xi$ is countably compact if and only if $|I| < 2^{\mathfrak{c}}$. However, the method did not allow to take powers nor could be used in infinite cardinals smaller than $2^{\mathfrak{c}}$.

In this talk we will sketch the construction of consistent examples to answer Comfort's Question in the affirmative for every cardinal $\alpha \leq 2^{\mathfrak{c}}$. Our examples do not require forcing nor some form of Martin's Axiom, only selective ultrafilters and the regularity of $2^{\mathfrak{c}}$. We improve a technique that appears in Tomita and Watson (Topology Appl., 2004) that showed that incomparable selective ultrafilters are Comfort-group incomparable.

Yolanda Torres Falcón *Universidad Autónoma Metropolitana - Iztapalapa* An example of a σ-compact monothetic group which is not compactly generated

abstract We construct a countable (hence σ-compact) monothetic topological group G which is not compactly generated, thus answering in the negative a question posed by Fujita and Shakhmatov. In addition, our group G is precompact and sequentially complete.

Hideki Tsuiki and Shuji Yamada *Kyoto University and Kyoto Sangyo University* Every Dense-in-itself Compact Metric Space has a Full $\{0, 1, \perp\}$-Representation

abstract

We consider a representation of a space X as infinite $\{0, 1, \perp\}$-sequences. More precisely,

(i) we consider an embedding φ of X in $\mathbb{T}^\omega$, which is the space of infinite $\{0, 1, \perp\}$-sequences with the Scott topology,

(ii) let $S_n^0 = \{x \in X \mid \varphi(x)[n] = 0\}$ and $S_n^1 = \{x \in X \mid \varphi(x)[n] = 1\}$. When $\varphi(x)[n] = \perp$, every neighbourhood of x intersects with both S_n^0 and S_n^1.

For such a representation, S_n^0 and S_n^1 are regular opens which are exterior of each other, and S_n^0, S_n^1 $(n = 0, 1, 2, \dots)$ forms a subbase of X, which we call a dyadic subbase [Tsuiki04, in Topology Proceedings].

We say that such a representation is full if all the $\{0, 1\}$-sequences are obtained by filling the bottoms of the images of φ with 0 and 1. Fullness corresponds to the no-redundancy of the representation.

In this talk, we show that every dense-in-itself compact metric space has a full $\{0, 1, \perp\}$-representation. This construction also entails that when a compact space X is embedable in I^n (it holds, when $n >= 2dimX + 1$), we can form a surjective continuous map from X to I^n, which is just like the space-filling Peano curve from I to I^n.

Jerry E. Vaughan *University of North Carolina at Greensboro.* On τ-pseudocompact spaces

abstract Here we consider $T_{3\frac{1}{2}}$-spaces, and infinite cardinals (denoted τ or κ). We present some new results concerning τ-pseudocompact spaces. Recall two definitions of J. F. Kennison: a space X is τ-pseudocompact provided $f(X)$ is a closed subset of $\mathbb{R}^\tau$ for every continuous function $f : X \to \mathbb{R}^\tau$, and a set $H \subset X$ is called a Z_τ-set provided H is the intersection of at most τ zero-sets. It is easy to see that τ-pseudocompactness is weaker than the classical property of Alexandroff-Urysohn *initially τ-compactness* (i.e., every open cover of cardinality at most τ has a finite subcover). A. V. Arhangel′slii defined a space to be Z_τ-normal provided for every pair H, K of disjoint sets with H a Z_τ-set and K a closed set, there exists a Z_τ-set G such that $K \subset G$ and $G \cap H = \emptyset$. Theorem 1: If X is Z_τ-normal, τ-pseudocompact and $< \tau$-bounded, then X is initially τ-compact. Theorem 2. If X is Z_τ-normal and τ-pseudocompact, then X is initially κ-compact for all κ such that $2^{<\kappa} \leq \tau$. These theorems generalize several known results.

Richard G. Wilson *Universidad Autónoma Metropolitana, Iztapalapa* Minimal properties between T_1 and T_2

abstract A space is a US-space if every convergent sequence has a unique limit; it is an SC-space if each convergent sequence together with its limit is closed and is a KC-space if every compact subset is closed. We study the existence of spaces which are minimal with respect to these properties. We obtain a number of results regarding minimal SC-spaces, we show that the class of infinite minimal US-spaces is empty and we give a consistent example of a Tychonoff topology which contains no minimal KC-topology. The only previously known example of such a space is not Hausdorff (see [F]).

[F] Fleissner, W. G., *A T_B-space which is not Katětov T_B*, Rocky Mountain J. Math., **10** no. 3 (1980), 661-663.

Kohzo Yamada *Department of Mathematics, Faculty of Education, Shizuoka University* Products of straight spaces with compact spaces

abstract A metric space X is called straight if any continuous function which is uniformly continuous on each set of a finite cover of X by closed sets, is itself uniformly continuous. In this talk, we show that for a straight space X, $X \times C$ is straight if and only if $X \times K$ is straight for eny compact metric space K. Furthermore, we show that for a straight space X, if $X \times C$ is straight, then X is precompact, where C is the convergent sequence $\{1/n : n \in N\}$ with its limit 0 in the real line with the usual metric. Note that the notion of straightness depends on the metric on X. Indeed, the above result yields that $\mathbb{R} \times C$ is not straight, where $\mathbb{R}$ means the real line with the usual metric. On the other hand, we show that $(0,\ 1) \times C$ is straight, where $(0,\ 1)$ means the unit open interval with the usual metric.

Kaori Yamazaki *University of Tsukuba* Base-normality and product spaces

abstract We introduce the notion of base-normality, which is a natural generalization of base-paracompactness introduced by J. E. Porter (2003). A space X is said to be *base-normal* if there is a base $\mathcal{B}$ for X with $|\mathcal{B}| = w(X)$, where $w(X)$ is the weight of X, such that every binary open cover $\{U_0, U_1\}$ of X admits a locally finite cover $\mathcal{B}'$ of X by members of $\mathcal{B}$ such that $\overline{\mathcal{B}'}$ refines $\{U_0, U_1\}$. Every base-normal space is normal. Note that a Hausdorff space X is base-paracompact if and only if X is base-normal and paracompact.

We prove the following:

Theorem 1. For a base-normal space X and a metrizable space Y, the product space $X \times Y$ is normal if and only if $X \times Y$ is base-normal.

Theorem 2. For the countable product $X = \Pi_{i \in N} X_i$ of spaces X_i such that finite subproducts $\Pi_{i \leq n} X_i$, $n \in N$, are base-normal, X is normal if and only if X is base-normal.

Theorem 3. Every Σ-product of metric spaces is base-normal.

Beatriz Zamora Aviles *York university* Countable Dense Homogeneity with Lipschitz functions.

abstract A topological space X is CDH if given A, B countable dense subsets of X, there exists $f : X \to X$ an homeomorphism such that $F[A] = B$. Two metric variants (iso-CDH and LCDH) of countable dense homogeneity are considered here. We show that every separable Banach space is LCDH, that is: Given A, B two countable dense subsets of a separable Banach space X and $\varepsilon \in (0, 1)$ there is an $f : X \to X$ such that $f[A] = B$ and $1 - \varepsilon \leq \frac{\rho(f(x), f(y))}{d(x,y)} \leq 1 + \varepsilon$ for every $x, y \in X$.

5. Knot Theory

Lorena Armas Sanabria *Instituto de Matematicas, UNAM* An example of a hyperbolic 3-manifold realizing a bound on Dehn fillings

abstract Let M be a compact, orientable, irreducible 3-manifold with an incompressible torus boundary T and γ a longitudinal slope on T, which bounds a surface F of genus 2. Suppose there exists a slope r that produces an essential 2-sphere S_1 by Dehn filling. Let q be the minimal geometric intersection number between the essential 2-sphere and the core of the Dehn filling. Matignon and Sayari proved that either $q = 2$ or the minimal geometric intersection number between γ and r is bounded by 3. In this talk we construct an example of a hyperbolic 3-manifold realizing that bound.

Javier Arsuaga *UCSF Comprehensive Cancer Center* DNA knots reveal a chiral organization of DNA in phage capsids

abstract It is believed that all icosahedral bacteriophages package their double-stranded DNA genomes to near-crystalline density in similar fashion. Nevertheless despite numerous studies, the organization of DNA inside viruses such as lambda, T4, T7, P2, P4, and Phi29 is still unknown. We propose a new approach to this problem. We recently showed that most DNA molecules extracted from bacteriophage P4 are highly knotted due to the cyclization of the linear DNA molecule confined inside the viral capsid. Here we show that these knots provide information about the global arrangement of the DNA inside the phage. We analysed the viral distributions of DNA knots by high-resolution gel electrophoresis and performed Monte Carlo computer simulations of random knotting confined to spherical volumes. A rigorous proof of non-random packaging of the phage DNA is given by comparing the knot distributions obtained by both techniques. Furthermore, our results indicate that the packaging geometry of the DNA inside the viral capsid is writhe directed

Masayuki Asaoka *Kyoto University, Japan* Geometry of projectively Anosov flows and bi-contact structures on 3-manifolds

abstract A **bi-contact structure** on a 3-manifold is a pair of mutually transverse positive and negative contact structures, which was introduced by Mitsumatsu, and Eliashberg and Thurston independently. Mitsumatsu found such a structure in his construction of new examples of symplectic 4-manifold by using Anosov flows on 3 manifolds. Eliashberg and Thurston also found it in their study on deformation of foliations into contact structures. Both of them observed that the intersection

of the plane fields of a bi-contact structure defines a flow which preserves a pair of integrable plane fields with a special property. Since such a flow is a kind of generalizations of an Anosov flow, they call it a **projectively Anosov ($\mathbb{P}$A) flow** (or a **conformally Anosov flow** in some literatures). They also showed that a bi-contact structure is obtained by a 'linear deformation' of one invariant plane field of a $\mathbb{P}$A flow by another one. It can be shown that the correspondence of bi-contact structures and $\mathbb{P}$A flows is one-to-one up to homotopy of these objects. Hence, one can study these objects from the view points both of contact geometry and of dynamical systems.

One of the main aim of the talk is to define and study some invariants of the above homotopy classes form the view point of dynamical systems. In fact, we define cohomology groups of a cochain complex generated by tori invariant under flow.n One of the appliaction of such invariants is that if some of them do not vanish then the flow is not homotopic to an Anosov flow, admit no smooth invariant foliations, and must have two periodic orbits. Because an analog of invariants for two dimensional $\mathbb{P}$A diffeomorphisms has a simple geometric meaning, we will explain the case for two dimensional diffeomorphisms in detail instead of three dimensional flows.

It is known that the plane fields invariant under a $\mathbb{P}$A flow are not smooth in general. In the context of deformation of foliations, it is important to ask when both of the invariant plane fields generate foliations. The same problem for Anosov flows has been considered from the view point of the rigidity of smooth foliations and was solved by Ghys. In fact, he showed that an Anosov flow with smooth invariant foliations is essentially equivalent to one of the classical examples: the suspensions of hyperbolic toral automorphisms or some kinds of deformation of geodesic flows on the unit tangent bundle of a surface of negative constant curvature. The second aim of the talk is to see that a similar rigidity result holds for $\mathbb{P}$A flows. In fact, any $\mathbb{P}$A flow with smooth invariant foliations is equivalent to an Anosov flow or can be decomposed into a finite number of so-called $\mathbb{T}^2 \times I$ models.

Mario Eudave Muñoz *IMUNAM* Essential tori after Dehn surgery

abstract We consider the following problem: How many disjoint, non-parallel, incompressible tori there can be after Dehn surgery on a hyperbolic knot in S^3 ?

We construct examples of hyperbolic knots k, such that for certain slope r, the r-surgered manifold $M_k(r)$ contains 2 or 3 disjoint, non-parallel, incompressible separating tori.

J. Manuel Garcia-Islas *CIMAT, Centro de Investigación en Matemáticas*
Observables in 3-dimensional quantum gravity and topological invariants

abstract This talk is based on a recent publication on which we describe a way to get topological invariants of graphs and knots embedded on 3-dimensional manifolds, based on a definition of observables in 3-dimensional quantum gravity. There is an intimate relation between knot theory, 3-dimensional manifold invariants and the physics of quantum gravity. We present this relation and then go further to describe the way in which we get our observable topological invariants. This gives a beatiful picture of how pure maths is related to the physics of the 21st century.

José-Carlos Gómez-Larrañaga *CIMAT* What we know about Lusternik-Schnirelmann type invariants in dimension three?

abstract In this talk we introduce what Clapp and Puppe call Lusternik-Schnirelmann type invariants for manifolds. Then we present what is known about these problems in dimension three including some new results by F. J. González-Acuña, W. Heil and the speaker.

Francisco González Acuña *IMATE-UNAM* Three-manifolds with S^1-category two

abstract (with José Carlos Gómez Larrañaga) An open subset U of a manifold M is S^1-contractible (in M) if there are maps $f : U \to S^1$, $\alpha : S^1 \to M$ such that αf is homotopic to the inclusion map. The smallest number m such that M can be covered with m open S^1-contractible subsets is denoted by $S^1 - cat(M)$ and is called the S^1-category of M.

Thm. If M^3 is a closed 3-manifold, $S^1 - cat(M3) = 2$ if and only if $\pi_1(M^3)$ is cyclic.

Gabriela Hinojosa *Universidad Autonoma del Estado de Morelos* Some topological properties of dynamically defined wild knots.

abstract Dynamically defined wild knots are wild knots in the sense of Artin and Fox, which are been obtained as limit sets of a Kleinian group. We say that a knot $K \subset \mathbb{S}^3$ is homogeneous, if given two points p, $q \in K$, there exists a homeomorphism $\psi : \mathbb{S}^3 \to \mathbb{S}^3$ such that $\psi(K) = K$ and $\psi(p) = q$. In general, wild knots are not homogeneous. The purpose of this talk is to show that dynamically defined wild knots are homogeneous. We will also show that the complement of a dynamically-defined fibered wild knot can not be a complete hyperbolic 3-manifold.

Mikami Hirasawa *Gakushuin Univ.* The flat basket presentation of Seifert surfaces and a new coding algorithm for links

abstract This is a joint work with T. Kobayashi (Nara Women's Univ) and Rei Furihata (Yosami Junior High School)

We introduce a new standard form of a Seifert surface F. In that standard form, F is obtained by successively plumbing flat annuli to one disk, where the gluing regions are all in the disk. We show that any link has a Seifert surface in the standard form, and thereby present a new way of coding a link.

Kazuhiro Ichihara *Osaka Sangyo University* Hyperbolicity of sections in surface bundles

abstract We consider the hyperbolicity of knots appearing as sections in 3-manifolds which fiber over the circle. In fact, on such knots, some sufficient conditions for being hyperbolic are given in terms of their projections on the fiber surface.

Atsushi Ishii and Taizo Kanenobu *Osaka University, Osaka City University* A relation between the LG polynomial and the Kauffman polynomial

abstract We give an explicit formula for the fact given by Links and Gould that a one variable reduction of the LG polynomial invariant coincides with a one variable reduction of the Kauffman polynomial. This implies that the crossing number of an adequate link may be obtained from the LG polynomial by using a result of Thistlethwaite. We also give some evaluations of the LG polynomial.

Edgar Jasso *IMATE-UNAM* Incompressible surfaces in tunnel number one link complements

abstract We construct for each n a tunnel number one link such that in its complement there exists a standardly embedded genus n surface that separates the components of the link. This is joint work with Mario Eudave-Muñoz.

Mercedes Jordán Santana *IMATE UNAM* Biquandle and Virtual Knots

abstract The birack is a set with two operations that provides a solution to the Yang Baxter equations. A biquandle is a particular case of a birack. Given a virtual knot we can use elements from a biquandle to give a labelling of the knot. It comes out that this labelling is an invariant of the knot. We give some examples of biquandles and virtual knots where the biquandle detects the non-triviality of the knot.

Naoko Kamada *Osaka City University (OCAMI)* Some relations on Miyazawa's virtual knot invariant

abstract Y. Miyazawa introduced a polynomial invariant for a virtual link at the regional conference in Yamagata, Japan, on January 2004. It is valued in $\mathbf{Z}[A, A^{-1}] + \mathbf{Z}[A, A^{-1}]h$, which is derived from virtual magnetic graph diagrams. The Jones-Kauffman polynomial (f-polynomial) is obtained from Miyazawa's polynomial by substituting 1 for h. For a virtual link diagram D_+ with a positive crossing p, D_- or D_v is the virtual link diagram obtained from D_+ by replacing a positive crossing p with a negative crossing or a virtual crossing, respactively. We call (D_+, D_-, D_v) a virtual skein triple. Some relations for virtual skein triple on the Jones-Kauffman polynomials were found. We discuss some relation for virtual skein triple on Miyazawa's polynomial.

Seiichi Kamada *Hiroshima University* Graphic descriptions of monodromy representations

abstract Various topological objects; 2-dimensional braids, Lefschetz fibrations of 4-manifolds, algebraic curves, hyperplane arrangements, etc., are treated by use of their monodromy representations. We introduce a graphic method to describe monodromy representations.

Akio Kawauchi *Osaka City University* Topological Imitations and Reni-Mecchia-Zimmermann's Conjecture

abstract We first explain the theory of topological imitations which has been developed since the speaker's paper in 1989. In particular, we explain the concepts of an AID imitation and a strongly AID imitation. We show how this imitation theory is applied to the hyperbolic 2-fold branched covering space of a knot. By M. Reni's work, it is known that there are at most nine inequivalent knots in the 3-sphere (or more generally at most nine inequivalent knots in Z_2-homology 3-spheres) with the same hyperbolic 2-fold branched covering. M. Mecchia and B. Zimmermann applied the imitation theory to show that there exist just nine inequivalent knots in Z-homology 3-spheres with the same hyperbolic 2-fold branched covering, and also showed by a similar method that there are six knots in the 3-sphere with the same hyperbolic 2-fold branched covering. Thus, it is naturally conjectured that there exist just nine inequivalent knots in the 3-sphere with the same hyperbolic 2-fold branched covering.

The main result in this talk is to solve their conjecture affirmatively by combining the strongly AID imitation theory with Mecchia-Zimmermann's method.

Christian Laing *Florida State University* The Writhe of a Polygonal Curve on a Lattice

abstract Given a polygonal closed curve on a lattice, we describe a method for computing the writhe of the curve as the average of weighted linking numbers of the polygon with pushoffs in a few directions. These directions are determined by the lattice, and the weights are determined by areas of regions on the unit 2-sphere, where the regions are formed by the tangent indicatrix to the polygonal curve. We discuss applications to ring polymers.

Daniel Moskovich *University Of Kyoto, RIMS* A Surgery Presentation for Irregular Branched Dihedral Covering Spaces of Knots

abstract This is joint work with Andrew Kricker. We describe a method to obtain surgery presentations for irregular branched dihedral covering spaces of knots, and we find such presentations explicitly for certain special knots and for the special case where the dihedral group is of order 3.

Yasutaka Naakanisi *Kobe University* Local moves and Gordian complices

abstract After their works of Gusarov and Habiro, it is known that a local move called C_n move is strongly related to Vassiliev invariants of order less than n. In this talk, we will consider the relationship is natural or not. Let K be a knot, and K^{C_n} the set of knots obtained from a knot K by a single C_n move. Let $\mathcal{V}_m$ be the set of Vassiliev invariants of order less than or equal to m $(m \geq 2)$, and $\mathcal{V}_m\mathcal{K}$ the value set $\{(v, \{v(K)\}_{K\in\mathcal{K}})\}_{v\in\mathcal{V}_{\Updownarrow}}$ for a set of knots $\mathcal{K}$. Our main result is the following: If m_1, m_2 are sufficiently greater than n, then there exists a pair of knots K_1, K_2 such that $\mathcal{V}_{m_1}K_1 = \mathcal{V}_{m_1}K_2$, and $\mathcal{V}_{m_2}K_1^{C_n} \neq \mathcal{V}_{m_2}K_2^{C_n}$. In other words, the C_n Gordian complex is not homogeneous with respect to Vassiliev invariants.

Max Neumann *IMATE-UNAM* Minimal lenght, minimal area and minimal intersections of curves and surfaces in dimensions 2 and 3.

abstract Geometry and topology are intimately related in 2 and 3 dimensional manifolds. Examples of this relationship are the connections between the geometric ideas of minimal lenght (or area) for immersed curves (or surfaces) and the topological idea of minimal intersections.

Víctor Núñez *Cimat* A couple of universal knots

abstract We show that two very interesting knots are universal, namely, $p(-2, 7, 7)$ and $p(-2, 11, 11)$. We review a classical method to draw preimages of knots in branched coverings.

Enrique Ramírez Losada *CIMAT* There exist infinitely many twocomponent links which are 2-universal

abstract A link or knot l is 2-universal if every closed orientable 3-manifold is a covering of S^3 branched along l, and all branched indices are one or two. We give a family of two component links which are 2-universal

Jesús Rodríguez Viorato *IMATE-UNAM* Dihedral coverings of Montesinos Knots.

abstract We show that many Montesinos knots are universal by understanding their dihedral coverings.

Toshio Saito *Osaka University* Dehn surgery on $(1,1)$-knots in lens spaces which yields the three sphere

abstract It is one of the unsolved problems to decide the knots in the 3-sphere which admit Dehn surgery yielding lens spaces. The concept of doubly primitive knots is introduced by Berge, and he proved that any doubly primitive knot admits Dehn surgery yielding a lens space. It is conjectured that Berge's list is complete. He also proved that the dual knots of the doubly primitive knots are $(1,1)$-knots. This implies that it is crucial to study $(1,1)$-knots with Dehn surgery yielding the three sphere. In this paper, we give some necessary conditions for $(1,1)$-knots in lens spaces which admit integral surgery yielding the 3-sphere. As an application, we can obtain a partial answer on a conjecture by Bleiler-Litherland.

Reiko Shinjo *Waseda University* Bounding disks to a spatial graph

abstract We consider Seifert surfaces of knots in a spatial graph whose interiors are mutually disjoint. We give the upper bound of the number of such surfaces. Then we show that for a given abstract graph there is a spatial embedding of the graph which realizes the upper bound.

Makoto Tamura *Osaka Sangyo University* Combinatorics on p-starred automatic groups

abstract We discuss the following question posed by Gersten: Is every (bi)automatic group which does not contain any Z+Z subgroup, hyperbolic? To study this question, we define the notion of "n-track of length n", which is a structure like Z+Z, and show its existence in the Cayley graph of non-hyperbolic automatic groups with mild conditions. Using this structure, we answer the above question affirmatively for p-starred automatic groups for prime integer p. (This is a joint work with Y. Nakagawa and Y. Yamashita (Nara Women's Univ.))

Masakazu Teragaito *Hiroshima University* On hyperbolic knots realizing the maximal distance between toroidal surgeries

abstract For a hyperbolic knot in the 3-sphere, the distance between toroidal surgeries is at most 5, except the figure eight knot. We determine all hyperbolic knots that admit two toroidal surgeries at distance 5. They are Eudave-Muõz knots $k(2,-1,n,0)$ for $n \neq 1$, and the toroidal slopes at distance 5 are $25n-16$ and $25n-37/2$. Also, we show that any Eudave-Muñoz knot admits at most three toroidal surgeries.

Yukihiro Tsutsumi *Sophia University, Japan* On Dehn surgery along ribbon knots of 1-fusion and the double branched covers

abstract A knot in S^3 is called a ribbon knot if it bounds an immersed disk whose singular set consists of ribbon singularities. J. Osoinach discovered an infinite sequence of knots K_i such that the 0-surgery manifolds $\chi(S^3;(K_i,0))$ are mutually homeomorphic and the volumes $\mathrm{vol}(K_i)$ converge on the volume of some link. We note that some results of Osoinach's construction are ribbon knots of 1-fusion. In this talk, we study some algebraic invariants for such knots. We give an infinite sequence of ribbon knots K_i of 1-fusion such that for any distinct integers $i \neq j$, (1) the 0-surgery manifolds $\chi(S^3;(K_i,0))$, $\chi(S^3;(K_j,0))$ are homeomorphic, (2) the double branched cover $\Sigma^2_{K_i}$ of S^3 branched along K_i is not homeomorphic to $\Sigma^2_{K_j}$. To show the second property we use the Casson-Walker invariant and Mizuma's formula for $J'_{K_i}(-1)$, the first derivative at -1 of the Jones polynomial.

Yoshiaki Uchida *Yamagata University* Double torus knots, tunnel number one knots, and essential disks

abstract Let W be a genus two handlebody, D essential disk, where if D is essential, D is properly embedded disk in W and not ∂-pararell in W. Cutting W along D, then we get a solid torus or two solid tori. In case of a solid torus, its core is a tunnel number one knot, in case of two solid tori, its core is a tunnel number one links. From this view, we will characteristic some tunnel number one knot.

Luis G. Valdez Sánchez *University of Texas at El Paso* Crosscap number two, tunnel number one knots without (1,1) decompositions

abstract Any genus one, tunnel number one hyperbolic knot in the 3-sphere admits a (1,1) decomposition and is, in fact, a 2-bridge knot. This is the content of the Goda-Teragaito conjecture, recently established by M. Scharlemann. In this talk we consider the similar case of crosscap number two, tunnel number one hyperbolic knots, give a simple classification of all such knots admitting (1,1) decompositions, and use this classification to construct an explicit infinite family of such knots without (1,1) decompositions. This is joint work with Enrique Ramirez (CIMAT, Mexico).

Mariel Vázquez *University of California at Berkeley* Enzymes that change the topology of DNA.

abstract (joint with De Witt Sumners, Sean D Colloms and Javier Arsuaga) DNA topology is the study of geometrical (supercoiling) and topological (knotting) properties of DNA loops and circular DNA molecules. Virtually every reaction involving DNA is influenced by DNA topology, or has topological effects. Site-specific recombinases and topoisomerases are enzymes able to change the topology of circular DNA by breaking the DNA and introducing one or more crossing changes. In this talk I will discuss mathematical and computational analyses of several enzymatic actions. These enzymes produce or remove DNA knots and links. We use knot theory and tangles to model the reactions and shed some light on the underlying biological processes.

Tsukasa Yashiro *Osaka City University* Crossing distances of surface-knots

abstract A surface–knot is an embedded oriented closed surface in 4–space. The unknotting number of a surface–knot is defined as the minimal number of handles attached to obtain a trivial surface. We define a distance between surface–knots as the minimal number of crossing components for all regular homotopy tracks between them. In this talk we will show that the crossing distance between a surface–knot and a trivial surface with the same genus is bounded below by the unknotting number of the surface–knot. Using this, we will determine distances for some surface–knots.

Gengyu Zhang *Tokyo Institute of Technology* 2-irreducibility of spatial graphs

abstract(Fengchun Lei,Kouki Taniyama and Gengyu Zhang)

An embedded graph G in the 3-sphere S^3 is called 2-irreducible if there are no separating spheres, cutting spheres, singular separating spheres, singular cutting spheres and 2-cutting spheres of G. Let D be a 2-disk in S^3 that is very good for G. Let G' be an embedded graph in S^3 obtained from G by contracting D to a point. We show that if G' is 2-irreducible then G is 2-irreducible. By this criterion certain graphs are easily shown to be 2-irreducible. As an application we show a pair of embedded graphs in the 3-sphere which is distinguished by 2-irreducibility.

6. Set Theory

Stefan Geschke *Free University of Berlin* A dual open coloring axiom

abstract I will discuss a dual of the version of the Open Coloring Axiom that was introduced by Abraham, Rubin, and Shelah and indicate how this dual OCA follows from a statement about continuous colorings on Polish spaces that is known to be consistent. I will also mention some consequences of the new axiom.

Neil Hindman *Howard University* Discrete n-tuples in Hausdorff spaces

abstract We investigate the following three questions: Let $n \in N$. For which Hausdorff spaces X is it true that whenever Γ is an arbitrary (respectively finite to one) (respectively injective) function from N^n to X, there must exist an infinite subset M of N such that $\Gamma[M^n]$ is discrete? Of course, if $n = 1$ the answer to all three questions is "all of them". For $n \geq 2$ the answers to the second and third questions are the same; in the case $n = 2$ that answer is "those for which there are only finitely many points which are the limit of injective sequences". The answers to the remaining instances involve the notion of *n-Ramsey limit*. We show also that the class of spaces satisfying these discreteness conclusions for all n includes the class of F-spaces. In particular, it includes the Stone-Čech compactification of any discrete space.

Justin Tatch Moore *Boise State University* Recent developments in basis problems

abstract I will present the following ZFC result.

Theorem: There is a hereditarily Lindelöf, non-separable space.

One immediate consequence is that the uncountable regular topological spaces do not have a three element basis. The combinatorial object which makes the construction work also gives a number of other examples. In particular it produces a binary relation R which is neither below $\omega \cdot \omega_1$ nor above $[\omega_1]^{<\omega}$ in the Tukey order. It also gives an example of a function c from $\omega_1 \times \omega_1$ to ω_1 which takes all values on any product of uncountable sets.

A.A. Salama *Department of Mathematics - Faculty of Education - Suez* - Compactness in Fuzzy Topological Spaces

abstract The purpose of this paper is to introduce and studied the concept of -compactness in the light of the concept of -shading in a fuzzy setting. A characterization of -compactness is given by using the concept of -finite intersection property due to [1]. We define the notion of fuzzy T2-space and by using it we give some properties of -compactness. Also the image and the inverse image of compactness under some types of functions are investigated. Keywords: Fuzzy topological spaces, fuzzy -compactness, fuzzy -compactness, fuzzy -near compactness, fuzzy -continuity, fuzzy weakly -continuity, fuzzy T2-space, fuzzy -open sets.

Juris Steprans *York University* Combinatorial questions associated with cardinal invariants of measure

abstravt The problem of obtaining models oof set theory where all sets of reals of size $\aleph_1$ are null yet there are sets of reals of cardinality $\aleph_1$ that are not null with respect to other natural measures involves establishing combinatorial lemmas about finite measure spaces. These will be discussed.

7. Continuum Theory

Wlodzimierz J. Charatonik and Matt Insall *University of Missouri-Rolla* Metrics on hyperspaces - intuition and theory

abstract We will argue that widely used in topology Hausdorff distance is a rough tool in practical applications (image processing, robotics, terrain analysis). Then, we will construct metrics, and we will argue that they possess some desirable properties. This approach leads to reach theory of discrepancy functions on hyperspaces, as well as possible practical applications.

Jorge M. Martínez Montejano *Instituto de Matemáticas, UNAM* C(X)-coselection spaces and Z-sets in hyperspaces

abstract Answers are provided to questions of Macías and Nadler about when the space of singletons is a Z-set in the hyperspace C(X). In answering one of these questions it is shown in general that C(X) being contractible is sufficient, but not necessary, for X to be a C(X)-coselection space.

Sergio Macías *Instituto de Matemáticas, UNAM* A characterization of homogeneous continua for which the set function T is continuous

abstract In his study of homogenoeus continua, Professor Jones defined what is called now the set function T as follows: Given a continuum X, we define T: P(X)->P(X) by T(A)=x in X | for any subcontinuum W of X with x in Int(W), W and A meet. If we restrcit T to the hyperspace of compact subests of X, 2^X, we may ask when T is continuous. We characterize homogeneous continua for which T is continuous.

Marcus Marsh *California State University, Sacramento* A Generalization of Brouwer's Fixed Point Theorem

abstract We generalize Brouwer's Fixed Point Theorem for n-balls B to a larger class of mappings whose images may not be a subset of B. Behavior of the mappings on the boundary of B, which also need not be mapped into B, is sufficient to determine the existence of fixed points. In the process, we generalize theorems of S. Eilenberg and E. Otto, of K. Morita, and of W. Holsztynski related to dimension and universal mappings.

Jesús F. Tenorio-Arvide *Benemŕita Universidad Autónoma de Puebla* Disk-like Products

abstract We prove that continua X and Y are atriodic and tree-like when the product XxY is disk-like.

Florencio Corona Vázquez *Benemérita Universidad Autónoma de Puebla* Compactifications of $[0, \infty)$ whose Cone have the Fixed Point Property

abstract We sketch the proof of the following result:

Theorem: Let X be a compactification of half-ray $S = [0, \infty)$ with remainder Y, where Y is a locally connected continuum such that $Cono(Y)$ has the fixed point property. If for each $\varepsilon > 0$ there exists a map $f_\varepsilon : S \to S$ such that f_ε is within ε of identity map on S and $f_\varepsilon(S)$ is contained in an arc, then $Cono(X)$ has the fixed point property.

Alejandro Illanes *IMATE-UNAM and CSUS* Counterexamples on hyperspaces

abstract Let X be a metric continuum (compact connected metric space). Let C(X)denote the hyperspace of subcontinua of X with the Hausdorff metric. It is known that, in general, C(X) has "nicer" properties than the space X. For example, C(X) is always arcwise connected even if X does not contain any arc. This situation has originated a lot of questions in the line of "how really nice are hyperspaces". In this talk we disscus some counterexamples that have solved some of these questions in the negative.

Gerardo Acosta *IMUNAM* Dinamics on Dendrites

abstract In this talk we study the dynamical behaviour of a homeomorphism f from a dendrite X onto itself. Given a point p of X we will show that either the omega limit set of p is a periodic orbit or a Cantor set. Recall that the omega limit set of p is the set consisting of all points which are limit of a subsequence of points in the orbit of p.

Carlos Islas *Facultad de Ciencias, UNAM* Ejemplos de continuos 2-equivalentes

abstract Un continuo es llamado 2-equivalente si slo contiene 2 tipos de subcontinuos no degenerados no homeomorfos. Slo existen caracterizaciones parciales de este tipo de continuos, adems se han dado familias de continuos que cumplen propiedades especficas. Usando lmites inversos se construyen algunos que cumplen o no la propiedad de Kelley.

Fernando Macas Romero *Facultad de Ciencias Físico Matemáticas (FCFM) de la Benemérita Universidad Autónoma de Puebla (BUAP)* A subset of the hyperspace of a continuum

abstract Let X be a continuum metric and $C(X)$ be the hyperspace of subcontinuum of X whit the Hausdorff metric. Let $L(X)$ be the space of subsets of X such that there exists a neighborhood U of A in $C(X)$ and a homeomorphisms f of U in $[0,1] \times [0,1]$ with the property $f(A) = (0,0)$. In this talk we give examples of the closure of $L(X)$ for certain continua X. Particularly, we see the case when the closure of $L(X)$ is homeomorphic to X and their consequences.

David Herrera-Carrasco *Universidad Nacional Autnoma de Mxico* HYPERSPACES OF DENDRITES

abstract A continuum one is a nonempty, nondegenerate, compact, connected metric space. We consider the following hyperspace of a continuum X, $2^X = \{A \subset X : A \text{ is nonempty and closed}\}$; $C(X) = \{A \in 2^X : A \text{ is connected}\}$. And for $n \geq 1$, $F_n(X) = \{A \in 2^X : A \text{ has at most } n \text{ points}\}$; $C_n(X) = \{A \in 2^X : A \text{ has at most } n \text{ components}\}$. All the hyperspaces are endowed with the Hausdorff metric H. A dendrite means a locally connected continuum containing no simple closed curve. We denote by D to the family of dendrite X, whose set of end points is closed and X is not an arc.

The author has shown:

Theorem 1. Let X in D and let Y be a continuum. If $C(X)$ is homeomorphic to $C(Y)$. then X is homeomorphic to Y; And the converse: Theorem 2. Let X a dendrite and X is not in D, then there exist continuum L such that X is not homeomorphic to L and $C(X)$ is homeomorphic to $C(L)$; Theorem 3. Let X and Y in D and $n \geq 3$. If $C_n(X)$ is homeomorphic to $C_n(Y)$, then X is homeomorphic to Y.

The purpose of this talk is to proved the following result:

Theorem. Let X in D, Y a dendrite and $n \geq 3$. If $C_n(X)$ is homeomorphic to $C_n(Y)$, then X is homeomorphic to Y.