

MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

Tagungsbericht 38|1978

Topologie

10.9. bis 16.9.1978

Die diesjährige Topologietagung stand wieder unter der Leitung von T.tom Dieck (Göttingen), K.Lamotke (Köln) und C.Thomas (London). In den Vorträgen wurden Probleme aus zahlreichen verschiedenen Gebieten der Topologie behandelt. Neben dem offiziellen Programm fanden auf Anregung von Tagungsteilnehmern einige weitere Vorträge vor Interessenten in kleinerem Kreis statt.

Teilnehmer

Abels,H., Bielefeld
Barthel,G., Konstanz
Bier,Th., Göttingen
Bix,M., Bonn
Clauwens,F., Nijmegen
Crabb,M.C., Bonn
Delinić,K., Heidelberg
tom Dieck,T., Göttingen
Ehlers,F., Bonn
Erle,D., Dortmund
Greuel,G.-M., Bonn
Hamm,H.A., Münster
Hauschild,H., Göttingen
Hirsch,U., Bonn
Jackowski,St., Warschau
Jänich,K., Regensburg
Kamber,F.W., Urbana
Karras,U., Dortmund
Kearton,C., Durham
Kervaire, M., Genf
Klingmann,M., Heidelberg
Kreck,M., Wuppertal

Lamotke, K., Köln
Lê, D.T., Paris
Lemaire, J.-M., Nizza
Löffler, P., Göttingen
Mayer, K.H., Dortmund
Meier, W., Siegen
Meyer, W., Bonn
Moonen, B., Köln
Oliver, R., Aarhus
Ossa, E., Wuppertal
Petrie, T., Princeton
du Plessis, A., Aarhus
Puppe, D., Heidelberg
Puppe, V., Konstanz
Scott, P., Liverpool
Siersma, D., Utrecht
Singhof, W., Köln
Smith, L., Göttingen
Stoltzfus, N.W., Baton Rouge
Strantzalos, P., Athen
Switzer, R. Göttingen
Triantafillou, G., Bonn
Vogel, J.A., Nijmegen
Vogel, P., Nantes
Vogt, E., Berlin
Vogt, R., Osnabrück
Waldhausen, F., Bielefeld
Wassermann, G., Regensburg

Vortragsauszüge

Clauwens, F. : Product formulae for surgery obstructions

The even dimensional case of the following theorem is stated and a sketch of proof is given :

Theorem : If $f : M \rightarrow N$ is a surgery problem with surgery obstruction represented by the quadratic form ψ over $\mathbb{Z}[\pi_1 N]$ and P is a closed manifold, we associate an "almost symmetric" form σ over $\mathbb{Z}[\pi_1 P]$ to P such that $\sigma \otimes \psi$ represents the surgery obstruction for $\text{id}_P \times f$. We discuss the geometric meaning of σ .

The theorem is then applied to generators of bordism of manifolds P with a homomorphism $\pi_1 P \rightarrow \pi$ for the case π cyclic. In this way one arrives at a characterization of σ in terms of characteristic numbers.

Crabb, M.C. : On the coefficient ring of $\mathbb{Z}/2$ -equivariant stable cohomotopy

The coefficient ring π_{**}^S of $\mathbb{Z}/2$ -equivariant stable cohomotopy is bigraded. We fix the indexing by the restriction map $\pi_{ij}^S \rightarrow \pi_i^S$ (forgetting the $\mathbb{Z}/2$ -action) and the fixed point map $\pi_{ij}^S \rightarrow \pi_j^S$. Operators T from $\pi_{i,j}^S$ to $\pi_{i+2,j}^S$ if $i-j \equiv 3 \pmod{4}$, to $\pi_{i+6,j}^S$ if $i-j \equiv 1 \pmod{4}$, and $\Lambda = T^2$ if $i-j$ is odd are defined, following Adams and Toda by means of S^3 - and S^1 -equivariant homotopy. These are used to define canonical subgroups of π_{**}^S . We work modulo odd torsion.

Theorem : There is a "natural" graded subring M_* of π_{*0}^S such that $\pi_{*0}^S = M_* \oplus \ker d$, where $d : \pi_{*0}^S \rightarrow KO_{*0}$ is the Hurewicz homomorphism to the coefficient ring of $\mathbb{Z}/2$ -equivariant real K -theory.

M_* is generated by $\pi_{-1,0}^S = \mathbb{Z}$ and the operator T .

Define a $\mathbb{Z}/2$ -cohomology theory J_{**} as the fibre of

$\psi^{3-1} : KO_{**}(2) \rightarrow KO_{**}(2)$. The image of the Hurewicz map $\pi_{**}^S \rightarrow J_{**}$ is easily computed using T : the method is due to Feder, Gitler and Lam, the result to Mahowald.

Delinić, K.: An intrinsic property of homotopy CW complexes

Following B. Gray (Homotopy Theory, Acad.Press,1975) we define a space X to be WANE (weak ANE) if for each metric pair (Y,B) , B closed in Y , and each map $f : B \rightarrow X$ there exists a neighbourhood V of B in Y and a homotopy extension $g : V \rightarrow X$ of f , i.e. $g|_B \approx f$. A WANE which has the homotopy type of some metric space will be called WANR (weak ANR).

Theorem : A space X has the homotopy type of a CW complex iff it is WANR.

Theorem : If a metric space X has an open cover such that each finite intersection of its members is WANE then X is WANE.

Greuel, G.-M.: On the topology of families of Riemann surfaces with singularities

Let $(X_0,0) \subset (\mathbb{C}^N,0)$ be a singularity of a Riemann surface (= reduced 1-dim complex space), ω_{X_0} the regular 1-forms on X_0 in the sense of Rosenlicht and $d : \mathcal{O}_{X_0} \rightarrow \omega_{X_0}$ the canonical derivation. We define

$$\mu(X_0,0) = \dim_{\mathbb{C}} \omega_{X_0,0} / d\mathcal{O}_{X_0,0}$$

to be the Milnor number of $(X_0,0)$. The following results show that this algebraic definition reflects very well the topological properties of μ which are known to hold for isolated hypersurface singularities (Milnor, Lê-Ramanujam):

$$(1) \mu(X_0,0) = 2\delta(X_0,0) - r(X_0,0) + 1,$$

$$\delta(X_0,0) = \dim_{\mathbb{C}} \overline{\mathcal{O}}_{X_0,0} / \mathcal{O}_{X_0,0}, \quad r(X_0,0) = \# \text{ branches } (X_0,0).$$

Let $X \subset B \times D$ be a surface, $B \subset \mathbb{C}^N$, $D \subset \mathbb{C}$ small balls around 0 and the projection $f : X \rightarrow D$ a flat deformation of $X_0 = f^{-1}(0)$:

$$(2) \quad \mu(X_0, 0) - \sum_{x \in \text{Sing}(X_t)} \mu(X_t, x) = b_1(X_t)$$

(= first Betti number of $X_t = f^{-1}(t), t \in D$)

(3) Let $\{0\} \times D \subset X$ and $X_t - \{0\}$ be smooth $\forall t \in D$. The following are equivalent: (a) $\mu(X_t, 0) = \text{const.}$ (b) $\delta(X_t, 0), r(X_t, 0) = \text{const.}$ (c) $b_1(X_t) \equiv 0$ (d) (B, X_0) homeomorphic (B, X_t) (e) $f: X \rightarrow D$ is topologically trivial.

Jackowski, St. : P-free linear representations of finite groups
(joint work with T. Zukowski)

Let P be a set of primes. A linear complex representation V of a finite group G is called P -free iff for every $v \in V$, $v \neq 0$, the order of the isotropy subgroup G_v is not divisible by any prime belonging to P .

We prove that a P -solvable group admits a P -free representation iff an arbitrary subgroup of G of order $p \cdot q, p, q \in P$ is cyclic. This result generalizes a theorem of Vincent and Wolf which describes groups having free representations. Our proof does not use the classification arguments of Vincent and Wolf.

It turns out that in case P consists of one prime p and G is p -solvable, then there is a p -free complex representation V such that $2 \dim_{\mathbb{C}} V$ is equal to the p -period of the group.

Kamber, F.W.: Characteristic classes of G-foliations

Foliations admitting a geometric structure on the normal bundle are investigated (G -foliations). Without assuming integrability of the geometric structure, a characteristic homomorphism is defined by the method of Kamher-Tondeur. In the integrable case, the resulting characteristic classes can be canonically represented by cocycles in an appropriate Gelfand-Fuks complex (using a method due to Heafliker). This leads to vanishing theorems for certain characteristic classes and thus to obstructions to integrability.

Karras, U.: On the topology of surface singularities

Two normal surface singularities (V_1, p_1) and (V_2, p_2) are defined to be topologically equivalent if the weighted dual graphs associated to their minimal good resolutions M_1 , respectively M_2 , are isomorphic and $\dim_{\mathbb{C}} H^1(M_1; \mathcal{O}_{M_1}) = \dim_{\mathbb{C}} H^1(M_2; \mathcal{O}_{M_2})$. There is some evidence that for hypersurface singularities the above definition is equivalent to the condition that their corresponding knots are homeomorphic. Let now $\{(V_t, p_t)\}$ be a deformation of (V, p) . Does the topological type of (V, p) determine the topological type of (V_t, p_t) ? Presumably, the answer is yes but up to now a complete proof can be only given in case of double points. Further, under the additional assumption that (V, p) is rational (res. minimally elliptic) there is an algorithm in terms of the given graph Γ by which it is possible to determine, at least in principle, the weighted dual graphs of all singularities appearing in fibres of normally flat deformations of (V, p) which admit a simultaneous resolution.

Kearon, C.: Signatures of knots

Let k be a classical knot, and $\Delta(t)$ its Alexander polynomial. Working over the real numbers, let $\lambda(t)$ be an irreducible symmetric factor of $\Delta(t)$, necessarily quadratic. Milnor has defined a signature $\sigma_{\theta}(k)$, where $\lambda(t) = t - 2\cos \theta + t^{-1}$, $0 < \theta < \pi$, which is a cobordism invariant of k . It is possible, via the Blanchfield duality pairing, to give an alternative definition of the Milnor signatures, and to compute them by means of the free differential calculus of Fox. In particular, the signatures of the (p, q) -torus knot can be obtained in this way.

Lê, D.T.: Topologie des espaces singuliers

Nous rappelons l'utilisation des stratifications pour étudier les singularités d'espaces analytiques complexes ou des espaces sous-analytiques réels. A cause des théorèmes d'isotopie de Thom et Mather, nous montrons l'importance des conditions de Whitney et de Thom pour ces stratifications. L'existence de ces stratifications est donnée par des théorèmes dus à Whitney et à Hironaka. Nous appliquons ces résultats pour démontrer le théorème de fibration suivant:

Soit $X \subset U \subset \mathbb{C}^N$ un espace analytique réduit fermé dans un voisinage ouvert U de 0 dans \mathbb{C}^N . Soit $f: X \rightarrow \mathbb{C}$ une fonction analytique. Pour $\varepsilon > 0$ assez petit et μ , $0 < \mu \ll \varepsilon$, on a une fibration topologique localement triviale:

$$X \cap B_\varepsilon \cap f^{-1}(D_\mu - (0)) \rightarrow D_\mu - (0)$$

induite par f avec $B_\varepsilon := \{z \in \mathbb{C}^N \mid \|z\| \leq \varepsilon\}$ et $D_\mu := \{z \in \mathbb{C} \mid |z| \leq \mu\}$.

Nous montrons comment la monodromie de cette fibration est quasi-unipotente en utilisant des arguments topologiques sans utiliser la résolution des singularités. Ce dernier résultat montre que le théorème de la monodromie est vrai sans supposer que la fibre générique de la fibration est non singulière.

Lemaire, J.-M.: Applications of "Quillen minimal models"

The Quillen minimal model of a 1-connected space has been introduced by H. Baues and the lecturer: it is a free minimal DG Lie algebra over \mathbb{Q} , unique up to isomorphism, which contains the whole information about the rational homotopy type of the space.

Using this notion, we can give a simple proof of the following fact, first proved by Schlesinger using techniques of Halperin and Stasheff, and some algebraic geometry: the set of rational homotopy types (1-connected) X such that $H_*(X; \mathbb{Q})$ is isomorphic to a given coalgebra is the quotient of an affine algebraic variety (over \mathbb{Q}) by an algebraic group. Moreover, effective calculations can be worked out in some simple cases.

Meier, W.: Acyclic maps and knot complements

The aim is to give a solution of the following homotopy theoretic problem: given a CW-complex Y , classify and construct all maps $f: X \rightarrow Y$ which induce an isomorphism

$$H_*(f;M) : H_*(X;M) \rightarrow H_*(Y;M) .$$

Here M denotes the group ring of $\pi_1(Y)$. Such maps f are called acyclic (maps), since they may be characterized by the property that $\tilde{H}_*(F;Z) = 0$, where F is the homotopy fibre of f .

The above problem has been posed by E. Dror, and by J.-C. Hausmann and D. Husemoller.

Our solution allows us to construct many spaces having the homotopy type of a knot complement up to the middle dimension.

Meyer, W.: Topologische und zahlentheoretische Anwendungen von Hirzebruchs Spitzenauflösungen
(gemeinsame Arbeit mit R. Sczech)

Sei K/Q ein totalreeller Körper vom Grad n , σ_K sein Ring der ganzen Zahlen sowie $f \in \sigma_K$ ein Primideal mit der (ungeraden) Norm $q = N(f)$. Über die Einbettung $K \hookrightarrow \mathbb{R}^n$ erhält man diskrete Untergruppen $\Gamma = SL_2 \sigma_K \hookrightarrow (SL_2 \mathbb{R})^n$ und

$$\Gamma(f) = \left\{ \begin{pmatrix} a & b \\ c & d \end{pmatrix} \middle| \begin{pmatrix} a & b \\ c & d \end{pmatrix} \equiv \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} (f) \right\} ,$$

die eigentlich diskontinuierlich auf dem n -fachen Produkt H^n der oberen Halbebene operieren. Der Quotient $X(f) = H^n / \Gamma(f)$ läßt sich durch endlich viele Spitzen zu einer normalen projektiven Varietät kompaktifizieren. Die Faktorgruppe $SL_2 \mathbb{F}_q = \Gamma / \Gamma(f)$ operiert auf einem nichtsingulären Modell $Y(f)$ von $X(f)$ und liefert so eine Darstellung π auf dem Raum $S_2(\Gamma(f)) \cong H^0(Y(f), \Omega^n)$ der Spitzenformen vom Gewicht 2 und der Stufe f . Seien γ_1, γ_2 die Multiplizitäten von G_1, G_2 , den irreduziblen Darstellungen

von $SL_2 \mathbb{F}_q$ vom Grad $(\epsilon + q) / 2$ ($\epsilon = (-1)^{\frac{q-1}{2}}$). Für $n = 2$

sind durch Hirzebruch die Spitzenauflösungen explizit angegeben worden. Diese erlauben die Berechnung der α -Invarianten gewisser Aktionen auf T^2 -Bündeln über S^1 . Es ergibt sich ein Zusammenhang zwischen diesen α -Invarianten und gewissen L-Reihen von Hecke. Damit erhält man schließlich
$$\gamma_2 - \gamma_1 = 2 \sum_L h(L)/h(K).$$
 Dabei sind $h(K), h(L)$ die Klassenzahlen der entsprechenden Körper, und die Summe läuft über alle totalimaginären quadratischen Erweiterungen L/K mit Führer f . Ferner ist $(f, 6) = 1$, $f \neq (\sqrt{5})$ vorausgesetzt, um zu garantieren, daß $\Gamma(f)$ frei auf H^2 operiert.

Puppe, D.: Duality in monoidal categories and applications to topology (joint work with A. Dold)

Two objects A, A' in a symmetric monoidal category \underline{C} are called strongly dual if multiplication by A is adjoint to multiplication by A' . In stable homotopy theory this is equivalent to S-duality. By direct geometric constructions we prove that a compact ANR $A \subset \mathbb{R}^n$ and its complement $\mathbb{R}^n \setminus A$ are S-dual (up to suspensions).

Corollaries of this are the Alexander duality and the Lefschetz-Hopf fixed point theorem.

Another application gives transfers for fibrations, where the hypothesis in the approach by Becker and Gottlieb that the base has finite dimension can be dropped.

Siersma, D.: Singularities of functions on boundaries, corners, etc.

Let $\mathbb{H}^q = \{ u \in \mathbb{R}^q \mid u_j > 0 \ j = 1, \dots, q \}$ be a q -dimensional corner. Consider the set of germs at $(0,0)$ of mappings $\mathbb{R}^p \times \mathbb{H}^q \rightarrow \mathbb{R}$ and call two germs equivalent if they differ by a germ of diffeomorphism $(\mathbb{R}^p \times \mathbb{H}^q, (0,0)) \rightarrow (\mathbb{R}^p \times \mathbb{H}^q, (0,0))$.

The purpose is to study those equivalence classes. Consider the mapping $\sigma : \mathbb{R}^p \times \mathbb{R}^q \rightarrow \mathbb{R}^p \times \mathbb{H}^q$ defined by

$$(x, u_1, \dots, u_q) \mapsto (x, u_1^2, \dots, u_q^2)$$

which is the orbit mapping of the group $G = (\mathbb{Z}_2)^q$ acting on $\mathbb{R}^p \times \mathbb{R}^q$ in the obvious way.

The principle step is to lift functions on $\mathbb{R}^p \times \mathbb{H}^q$ and diffeomorphisms of $\mathbb{R}^p \times \mathbb{H}^q$ to invariant functions on $\mathbb{R}^p \times \mathbb{R}^q$ and equivariant diffeomorphisms of $\mathbb{R}^p \times \mathbb{R}^q$. Next one can apply Wassermann's studies of symmetric singularities and list all singularities in low codimensions and study their unfoldings.

Singhof, W.: Minimal coverings of manifolds with balls

Given a closed manifold M , denote by $C(M)$ the minimal number of balls needed to cover M . It is well-known that $C(M) < \dim M + 1$. We show that $C(M)$ equals the Ljusternik-Schnirelmann category $\text{cat } M$ if $C(M)$ and $\text{cat } M$ are not both too low compared with $\dim M$. This is proved by using handlebody theory and the Engulfing Theorem. As an application, if $G_{n,k}$ denotes the Grassmannian of n -planes in \mathbb{R}^{n+k} , we have that $C(G_{n,k}) = \dim G_{n,k} + 1$ only in the following three cases: (i) $n = 1$ or $k = 1$, (ii) $n = 2$ and $k = 2^m - 1$, (iii) $k = 2$ and $n = 2^m - 1$. As a further application, $\text{cat}(M \times S^1) = \text{cat } M + 1$ if $\text{cat } M$ is not too low compared with $\dim M$.

Stoltzfus, N.W.: Knot theory and the arithmetic of algebraic number fields

Many of the most useful invariants of classical knot theory are associated to the knot module, the integral homology of the infinite cyclic covering of the complement of a knot.

With rational coefficients, the structure is well understood and the relationship with the integral lattice can be clarified using localization techniques.

If the Alexander polynomial is irreducible, the knot module classification is related to the classification of modules over orders in algebraic number fields. This is known for the maximal order but examples occur when the order is non-maximal or the module is non-projective. If the Alexander polynomial factors, we can describe invariants which measure the failure of a direct sum decomposition. Different algebraic equivalence relations are reflected geometrically giving a new group of knots which is non-trivial in all dimensions, in contrast with the ordinary knot concordance group.

Strantzas, P.: Dynamische Systeme mit Charakteristik O^+ auf 2-dimensionalen Mannigfaltigkeiten

Sei M eine 2-dimensionale Mannigfaltigkeit. Ein dynamisches System (D.S.) (\mathbb{R}, M) hat Charakteristik O^+ ($(\mathbb{R}, M) \in O^+$), wenn jede abgeschlossene und positiv-invariante Menge $B \subset M$ D -stabil ist; d.h. $D^+(B) = B$. Die D -Stabilität ist äquivalent mit der Liapunov-Stabilität, falls B kompakten Rand hat, sonst ist die D -Stabilität allgemeiner.

Die nicht trivialen $(\mathbb{R}, M) \in O^+$ lassen sich folgendermaßen klassifizieren: (1) S^2, P_2, T^2 und die Kleinsche Flasche sind die einzigen kompakten M 's, die $(\mathbb{R}, M) \in O^+$ erlauben. Für nicht kompaktes M sind die $(\mathbb{R}, M) \in O^+$, die einen "Maximalitätsbegriff" erfüllen, von folgender Art: (2) \mathbb{R}^2 und $S^1 \times \mathbb{R}$ sind die einzigen orientierten M 's, die $(\mathbb{R}, M) \in O^+$ mit Grenzkreisen erlauben. (3) $(\mathbb{R}, M) \in O^+$ mit nicht kompaktem M und ohne Grenzkreise sind von folgender Art: (a) Es gibt eine kompakte und zusammenhängende Menge von Fixpunkten, die global asymptotisch-stabil ist. (b) (\mathbb{R}, M) ist parallelisierbar. (c) Das Komplement der Fixpunktmenge ist abzählbar viele disjunkte, invariante und offene Mengen zerlegt, die zu \mathbb{R}^2 oder zu $S^1 \times \mathbb{R}$ homöomorph sind. Die Einschränkung des D.S. auf diese Mengen ist

parallelisierbar.

Bis jetzt waren nur die $(\mathbb{R}, \mathbb{R}^2) \in \mathcal{O}^+$ klassifiziert worden. Methoden aus der Theorie der eigentlichen Aktionen spielen bei der oben formulierten Klassifizierung eine wichtige Rolle.

Switzer, R.: 2-plane bundles over complex projective spaces and the e-invariant

If one wishes to classify 2-plane bundles over $\mathbb{C}P^n$ one could proceed by asking a) when does a stable complex bundle $\xi \downarrow \mathbb{C}P^n$ exist with c_1, c_2 given and $c_k \xi = 0, k \geq 3$? b) Given a fixed such stable bundle, how many non-isomorphic 2-plane bundles are there in it? The condition of Schwarzenberger gives the answer to a).

Thm. 1 (A.Thomas). Integers c_1, \dots, c_n are the Chern classes of a stable bundle $\xi \downarrow \mathbb{C}P^n$ iff they satisfy

S_n : with $y^n + c_1 y^{n-1} + \dots + c_n = \prod_{j=1}^n (y + \delta_j)$
one has $\sum_{j=1}^n \binom{\delta_j}{r} \in \mathbb{Z}, 2 \leq r \leq n.$

Now suppose such a $\xi \downarrow \mathbb{C}P^{n+1}$ to be fixed and suppose $\eta \downarrow \mathbb{C}P^n$ is a 2-plane bundle representing $\xi|_{\mathbb{C}P^n}$. Can we extend η over $\mathbb{C}P^{n+1}$? This is possible precisely when

$$S^{2n+1} \xrightarrow{\text{Hopf}} \mathbb{C}P^n \xrightarrow{\eta} BU(2)$$

is null-homotopic or equivalently when its adjoint $f : S^{2n} \rightarrow S^3 \rightarrow U(2)$ is null-homotopic. What is $e_{\mathbb{C}}(f)$?

Of course by Thm. 1 $\binom{\delta_1}{n+1} + \binom{\delta_2}{n+1}$ must be in \mathbb{Z} , so the following is not surprising.

Thm. 2 $e_{\mathbb{C}}(f) = \binom{\delta_1}{n+1} + \binom{\delta_2}{n+1} \in \mathbb{Q}/\mathbb{Z}.$

Corresponding results for symplectic line bundles over $\mathbb{H}P^n$ are also given.



Vogel, P.: Immersionen und embeddings in metastable dimension

Let $f : V \rightarrow M$ be an immersion. I want to show at what condition this immersion is regular homotopic to an embedding. This problem splits into two problems. The first is to know under what condition f is cobordant to an embedding in a strong sense. The second is to find a sufficiently strong notion of cobordism in order to be able to transform by surgery the cobordism into a s -cobordism.

Now replace the map $f : V \rightarrow M$ by a Hurewicz fibration $X \rightarrow M$, and let ξ be the vector bundle over X pulled back from the normal bundle of f by the homotopy equivalence $V \xrightarrow{\sim} X$. Let $T \rightarrow M$ be the fibration obtained from $X \rightarrow M$ by changing the fibers into the Thom spaces of the vector bundle ξ restricted to the fibers. Let $\Lambda \rightarrow M$ be the fibration obtained from $T \rightarrow M$ by changing the fibers F into $\Omega^{\infty} S^{\infty} F$. The fibration $\Lambda \rightarrow M$ contains $T \rightarrow M$ as a subfibration.

Transversality theorem: The immersion f induces a section σ of $\Lambda \rightarrow M$. And f is cobordant to an embedding (in the strong sense) if and only if σ is homotopic to a section of $T \rightarrow M$.

Surgery theorem: If $\dim M > \frac{3}{2} \dim V + 1$, f is regular homotopic to an embedding if and only if f is cobordant to an embedding (in the strong sense).

W.Singhof

