A SUMMARY OF MY MATHEMATICS.

My published papers belong to the fields of *algebraic and geometric topology* and *geometric analysis*. The papers on *algebraic and geometric topology* are about stable simplicial topology, infinite dimensional topology of Hilbert manifolds, automorphisms (diffeomorphisms and homeomorphisms) of compact manifolds, transformation groups, rational homotopy theory, homological algebra and algebraic K-Theory. The papers on *geometric analysis* are about infinite dimensional (complex analytic) manifolds, spectral theory of elliptic operators (regularized determinants), spectral geometry, nonlinear differential operators.

Here are five of my most known results:
(1) *the diffeomorphism of homotopy equivalent Hilbert manifolds of infinite dimension and the isotopy of homotopic diffeomorphisms between such manifolds,*
(2) *the determination of the homotopy type of the space of diffeomorphisms and homeomorphisms of a compact manifold in terms of homotopy theoretic invariants (like algebraic K-theory and Hermitian algebraic K-theory of the underlying topological space*, and more recently, *in terms of the homology of the free loop space of the underlying space,*
(3) *the calculation of the cyclic homology of the group rings,*
(4) *algebraic K-theory of a 1-conected space X tensored by rationals is the same as equivariant cohomology of the free loop space of X with rational coefficients*
(5) *the equality of the L_2 analytic and the L_2 Reidemeister torsion.*

At present my work is focussed on :
i) the relationship between spectral geometry, topolgy and dynamics,
ii) Von Neumann type invariants in algebraic and geometric topology,
and on a topic I call
iii)"asymptotic symmetry", inspired by the theory of quasi crystals and by some symmetry questions in biology.

Bellow are few comments about the four results mentioned above:
About (1): The diffeomorphism of homotopy equivalent Hilbert manifolds (proven in collaboration with N.Kuiper) complemented by a few additional results, implies that the homotopy theory and the differential topology of infinite dimensional Hilbert manifolds are equivalent. This mathematical truth has changed the intuition about infinite dimensional objects and, as noticed by R. Thom in late 60's, has revised the role of infinite dimensional manifolds in global analysis. This result and subsequent developments have applications in nonlinear analysis cf. (83) [1] and its references.
About (2): The understanding of the homotopy type of the space of automorphisms of compact manifolds is the next basic problem about manifolds (after the classification problem). The results on this "next" problem can be relevant even to fields as distant from topology as hydrodynamics, plasma and gravitation theory. My work provides the description of the homotopy type of the groups of diffeomorphisms and homeomorphisms for compact manifolds of dimension ≥ 5 and in the stable range. It began in collaboration with P. Kahn and P Antonelli and has continued in collaboration with R.Lashof and M.Rothenberg. The immediate application was the calculation of the rank of homotopy groups of the space of diffeomorphisms and homeomorphisms for 1-connected n-dimensional manifolds in the

[1] the number refers to the item in Publications list

range $< n/3$. This work led to the discovery of an unexpected relationship between the spaces of the Riemannian structures and of nonparametrized closed curves on a compact manifold, a relationship still far from being well understood. A key fact in this discovery was the observation that Connes' cyclic homology, fits perfectly with the calculation of the homotopy groups of the spaces of diffeomorphisms.

About (3): This work contains the calculation of the cyclic homology of a group ring. This calculation which is actually a result about the structure of this cyclic homology, has proven to be relevant in other fields of mathematics and has significant generalizations; it was essential in the partial solution of Bass' conjecture in algebra (B. Eckmann, I.Emmanoil), useful in Connes-Moscovici partial solution of Novikov conjecture, and is promising in representation theory. A result obtained in collaboration with Z.Fiedorowicz, which states that the equivariant homology of the free loop spaces can be calculated as cyclic homology, is a generalization of this calculation. This generalization led to the discovery of a striking analogy between the algebraic topology of the free loop spaces and the algebraic geometry of varieties over a finite field and to an algorithm for the computation of the cyclic homology of the commutative algebras. Further, it has revealed a role for cyclic homology in the local theory of singularities (cf. 60)

About (4); Waldhausen has extended the algebraic K-theory of group rings $Z[G]$ to connected topological spaces X, introducing a new homotopy theoretic functor $A(X)$ which turned out to be higly relevant for geometric topology. Using cyclic homology and rational homotopy theory I have calculated, for any X 1-connected, the rank of the homotopy groups of $A(X)$. I obtained these ranks in terms of cyclic homology and then (in collaboration with with Z. Fiedorowicz) in terms of the the S^1 equivariant homology of the free loop space of X. This work was an imporatant intermediade step in (2) and led to the Hermitian algebraic K-theory of spaces, (introduced in collaboration with Z.Fiedorowicz). The Hermitian algebraic K-theory of spaces is important for the understanding of the homotopy type of the space of homeomorphisms of a compact manifold.

About (5): It was observed since early 60's that the linear algebra which emerged from the work of von Neumann in early 40's can be used to produce new numerical invariants for non simply connected compact manifolds referred to as von Neumann invariants. These invariants can be defined both analytically and combinatorially and in all but one case the equality of the combinatorial and analytic invariants was not hard to prove. That one case was the case of the L_2-analytic and L_2-Reidemeister torsion. The equality of these two numbers became an important conjecture in the field. It gained recognition both because of technical difficulties to have it settled and because of the new geometric meanings these numbers have recently acquired. The conjecture was proved in 1996 by Friedlander, Kappeler McDonald and myself using sophisticated analytic tools we have developed before, like Witten deformation, the Mayer Vietoris formula for regularized determinants, and other. The paper where this result is established presents, in addition to the proof of the conjecture, the analytic tools necessary for the analytic approach to von Neumann invariants. This work led to new concepts and new conjectures in the field of von Neumann invariants as well as considerable generalizations (cf. 81). It is expected that these new conjectures will link the field of topology with fields far apart from topology, such as automata theory, random walks and non commutative probabilities.