# Robert MacPherson seen through the eyes of others

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*Happy Birthday, Bob!*

## 1 Introduction

Robert MacPherson has made fundamental contributions to many branches of mathematics. His best known result is probably the joint work with Mark Goresky which established the intersection (co)homology of singular spaces.[1] Another major piece of work, joint with Bill Fulton, also concerns the intersection theory, which is rooted in a problem of Hilbert and led to the award[2] winning book by Bill Fulton. [3]

A partial list of other major topics in his work is the following:

1. Stratified Morse theory[4]

2. Characteristic classes of singular spaces, Rimann-Roch, K-groups etc.

3. Topological trace formula and weighted cohomology

[1]See Steven Kleiman's survey paper for the discovery and many applications of the intersection homology, *The development of intersection homology theory*, in **A century of mathematics in America**, Part II, 543–585, Hist. Math., 2, Amer. Math. Soc., Providence, RI, 1989.

[2]1996 Steele Prize of the American Mathematical Society.

[3]Intersection Theory, Ergebnisse der Mathematik und ihrer Grenzgebiete. 3. Folge., Springer, 1998.

[4]See the survey article by David Massey in the special issues of Pure and Applied Mathematics Quarterly.

4. Geometric approach to Langlands program (equivariant cohomology etc)

5. Reduction theory and geometry of locally symmetric varieties[5]

6. Kalai conjecture on IH of toric varieties

7. Combinatorial manifolds

8. Configuration spaces and compactifications of various spaces

9. Polylogarithms, etc

His approach to mathematics is geometric.[6] In fact, his lectures are also geometric. Pictures and diagrams in colors are an important part. When I first attended his lectures at MIT, I stared at the blackboard with horror about taking the lecture notes since I only had one black pen but he used 5 different colors!

He has received many honors for his contributions.[7] In the following, we put together various comments/quotes from his friends, students and colleagues.

**Acknowledgments:** I would like to thank all the people who have generously contributed to the quotes and comments cited below, in particular Paul Gunnells for carefully reading an earlier version .

# 2 His trips to the former Soviet Union

MacPherson has made many trips to the former Soviet Union, and Russia and offered many kinds of help during the difficult times there.

*Sasha Beilinson explained*:

Bob once mused that the countries he feels happy in are coincidentally the most corrupt ones - namely, Italy and Russia. Sharing the most tender

[5] See the survey article by Paul Gunnells in the special issues of Pure and Applied Mathematics Quarterly.

[6] One could say that MacPherson is a geometric topologist (or algebraist), or a topological (algebraic) geometer. Besides being a mathematician, he is also an accomplished carpenter and enjoys building many things. He also enjoys cooking and experiments with various cuisines.

[7] See the IAS Letter, Fall 2004, for a summary.

feelings towards the former and having been formed in the latter, I was introduced to America mostly by Bob. Here is a small souvenir of few lines tinged with cosmopolitan symmetry.[8]

The great MacPherson I was aware of since childhood, was Jamie of "M'Pherson's Farewell", a famous fiddler and Robin Hood-like freebooter, hanged at Banff in 1700. So Bob's name was not foreign to me when we first met at the Gelfand seminar, probably, at the end of 1979. Bob was then in Moscow for the whole winter together with his wife Carol. He taught us about intersection homology, while Joe Bernstein gave a series of talks on holonomic D-modules. No one saw the relation, and it took another push from Kazhdan-Lusztig's work to open the eyes.

For years, Bob's visits to Moscow were a pure gift for many of us; I hope he also enjoyed the easygoing Moscow company. A snapshot: as a security measure, they set up a platoon of police to guard the University doors.[9] Those with no proper pass had to climb a fence - either a huge one with embroidery on the top that led directly to a court, or its smaller cousin around the discharge gates of the university canteens. Once, on the way to Manin's seminar, Bob shared with me the second route. After gracefully negotiating the palisade, he was unsettled by a vat of slops rolling at us inexorably from the entrails of the building.

Russian officialdom was perceived by the public mainly through anecdotes which created another reality, much more fascinating than the bleak view from the window. With acceleration of time, the two bubbles converged. They met as Mathias Rust's Cessna touched the Red Square on May 28, 1987; the burst made the Soviet Union collapse (though it took a while to see this clearly). I had a bet with Bob on the event (the condition was that in a year and a half the Baltic Republics plus some other part of SU would split off), which I lost by several months.

After the surrealistic "coup" of August 1991, all were happy. Live faces could be seen even at stately places, where no normal person could have been imagined before. The strange period of grace lasted for half a year; then the door was shut.[10]

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[8] "Cosmopolitan," a person at home in any country, but especially in Italy if an Englishman, and in France if a Russian. (V. Nabokov, "Commentary to Eugene Onegin").

[9] The untold reason was that one day terrorists came to the presidential floor of the building, rolled up the immense carpets, and disappeared with them.

[10] For an account of the subsequent black hole evolution, see D. Satter "Darkness at Dawn: The Rise of the Russian Criminal State", Yale University Press, 2003.

Soon after, with salaries denied, the Russian mathematicians who had no money from trips abroad (or lacked a potato patch to tend), found themselves in dire straits. To cope with the crisis, Bob launched the AMS fSU Aid Fund.[11] Together with Galya Kovaleva, Serezha Gelfand, Tim Goggins, Bus Jaco, and others, he handled unending lists of mathematicians of every kind and variety, commanded the smuggling of cash (the sprouting Russian banks were less than reliable) and its direct distribution. Despite all the mess, the scheme worked.[12] This was a noble and truly generous deed. We all owe Bob our deepest gratitude.

At the same time, with the new authorities absorbed in the growth of chelicerae, many remarkable things became possible - among them, the birth of the Independent University of Moscow which did so much for bringing new life to the Moscow mathematics. Bob's heart and energy were instrumental for its existence. It is a short walk on old streets to get to IUM from the exit of "Kropotkinskaya" metro station, its posts covered with advertisements of affordable black magic services, and a huge bronze Engels looking with pride and satisfaction at the enormous decoration of the Christ the Savior.

In Spring 1987, near the US consulate in Moscow, Bob filled in an invitation form for me. For several beautiful fall seasons I was in Boston. I perceived America through the eyes of a child. For a Muscovite even a beautiful skunk taking an evening stroll is a wonder, to say nothing about the bliss of an Indian Summer. Bob and Mark's home on the brink at Quincy with its windows wide into the Bay was of the same chain of marvels as the lights on a night highway I first saw from the window of Bob's car, and the hills of Vermont. Once Bob and Mark took me and my wife on their boat. Prior to us, a flock of Monarchs made a landfall on one of the tiny islands - a vision akin to Bilbo's experience at a treetop of Mirkwood. As well, Bob taught us many things practical, such as how to choose right corn and cook it properly; due much to his influence, our very first acquisition after moving to Chicago was a canoe.

Since then, Bob and Mark moved to a Princeton house with two small frogs in a basin at the backyard. Seeing him is always a joy. Meanwhile, the US became a déjà vu of my country of the days I first saw Bob, a land that abandoned the knowledge that "security is mortals' chiefest enemy",[13] with

[11] See Bob's articles in Notices of the AMS, vol. 40 (1993), no. 2.

[12] There were 487 grants for the total amount of \$550.000; of them \$100.000 were private donations, the rest came from the Sloan and Soros foundations.

[13] "Macbeth" III 5.

no moving wood in sight.

## 3 In the eyes of friends

*MacPherson's work in combinatorics is summarized by Anders Björner*:

Robert MacPherson and combinatorics

Bob has had a great direct and indirect impact on several recent developments in combinatorics. Among his ideas that have directly influenced developments, let me mention three especially:

1. Subspace arrangements. The Goresky-MacPherson combinatorial formula for the cohomology of complements of subspace arrangements, discovered as an application of "stratified Morse theory", has inspired much further work in topological combinatorics. It has also found applications to lower bound problems in computational complexity theory. 2. Intersection cohomology. This vast theory underlies such things as toric $h$-vectors of polytopes and Kazhdan-Lusztig polynomials of crystallographic Coxeter groups. Much work has been devoted to understanding the combinatorial consequences and underpinnings of these concepts. 3. Combinatorial geometries. Bob has had several fruitful ideas about using combinatorial gadgets, such as oriented matroids, as building stones of discrete analogues of classical constructions of differential geometry. He is the main architect behind the emerging theories of such things as matroid bundles, combinatorial differential manifolds and "MacPhersonians" (discrete analogues of Grassmannians).

What I have in mind when speaking of Bob's indirect impact is the deep appreciation and respect he shows toward combinatorial mathematics. This attitude has influenced several "mainstream" mathematicians as well as his students. Perhaps his mindset is best illustrated by a quote from Paul Gunnells' informative guide "Tips for potential students of Bob MacPherson. One piece of advice for such student is: "Never refer to any mathematical problem by 'But it's *just combinatorics.*' "

*A long time friend and colleague Robert Kottwitz commented*:

It has been a privilege for me to observe Bob MacPherson's incisive geometric intuition at work in understanding the complexities of affine Springer fibers. Their relevance to harmonic analysis on p-adic groups makes it worthwhile to study these objects carefully, but, as anyone who has actually looked at them knows, their internal structure is far too complicated to understand in full detail. Instead, one must try to discern meaningful patterns based on the few low-dimensional examples that can be calculated explicitly. Time after time, in joint work with Mark Goresky and myself, Bob MacPherson has brought his astonishing insight to bear on this problem (and others), and come up with ideas, imprecise at first, that later have grown into theorems and even theories. Collaborating with him is a wonderful learning experience!

*Jean-Paul Brasselet wrote*:

I am always very impressed by (at least) two points in Bob mathematical and human relationship : His kindness (in the most positive sense) and modesty. That is a quality that I appreciate : Bob never played the grand monsieur .

I am always impressed by the geometrical Bob's intuition : going immediately to the essential and geometrical point, and in the simplest way. I have seen that in two occasions : on the definitions of characteristic classes for singular varieties : Bob gave a very natural definition and that did not empeach him to appreciate and to enjoy the Marie-Hélène Schwartz definition. The other occasion is when I came to Boston to work with him and with Mark Goresky on the de Rham theorem. Bob gave several times simple geometrical interpretation of formulas or results we found, providing new insight to these results. I have been really very impressed.

On 22th March 1965 Marie-Hélène Schwartz published two "Notes aux CRAS " about characteristic classes for analytic singular varieties embedded in a smooth one (in relative cohomology groups). Then Bob proved, in 1974 the Deligne-Grothendieck conjecture about existence and unicity of a Chern transformation functor in the complex algebraic setting. At that time, in Paris, Bob was with Gelfand and they entered in a shop on the Boulevard Saint-Michel, as Gelfand wanted to buy some clothes for relatives. Marie-Hélène Schwartz was already in the shop (she entered to buy a "vert pomme" shirt for Laurent). In the narrow shop, Gelfand introduced Bob to Marie-Hélène who looked at him firstly "at the level of her eyes" then up! They began to discuss about characteristic classes in the narrow shop, enjoying the discussion and forgetting the reason for which they were there. That meeting has been the beginning of the story of equivalence of Marie-Hélène and Bob classes, now called Schwartz-MacPherson classes.

I have to say that Bob enjoyed the fact that Marie-Hélène classes correspond to his ones (for the constructible function 1) and the proof we gave. In a very kind friendship way, he participated to all events in honour of Marie-Hélène.

*David Massey described Bob's impact on him*:

I arrived in Boston in the summer of 1988 as an NSF postdoctoral research fellow. At that time, Terry Gaffney, Mark Goresky, and Lê Dũng Tráng were at Northeastern University, and Bob MacPherson was at MIT. Thus, Boston was definitely the best place to be in the United States for research in singular spaces.

I had just developed the Lê cycles and Lê numbers of non-isolated hypersurface singularities, and Lê had suggested to me that the Lê numbers must be some kind of iterated vanishing cycles. Consequently, I decided that I needed to learn about the derived category, perverse sheaves, and nearby and vanishing cycles. Mark, Tráng, and Bob cheerfully (as nearly as I could tell) endured many, many low-level questions from me.

In the spring of 1989, Bob offered a seminar course at MIT: The Geometry and Topology of Singular Spaces. In this course, Bob covered toric varieties and his then-developing characterization of perverse sheaves via Eilenberg-Steenrod-type axioms. What a course! Here was a master of a subject, presenting mathematics that was essentially "hot off the presses". Bob's overview of the area, his enthusiasm, his creativity and brilliance, his beautiful exposition, and his even more beautiful examples made the course fun, exciting, and memorable for all who attended.

However, for me, personally, the mathematics that I learned in Bob's course was not as important as what I learned during one several-hour-long conversation with Bob.

By September of 1989, I had learned some of the basic material on the derived category and perverse sheaves, and had used it to prove an interesting little result on the cohomology of the Milnor fiber of an affine hypersurface with a one-dimensional singular set. Related to this work, I found that a result of Siersma on "isolated line singularities" put an interesting restriction on the the vanishing cycles. I decided that I should talk to Bob about this result, and related questions, and he agreed to meet with me.

I told Bob about Siersma's result, and that it lead to the question: can one characterize precisely which perverse sheaves on a line can be realized as the vanishing cycles of an affine hypersurface singularity (with constant coefficients)? I was pleased when Bob said that he thought this was a very interesting question. Then, three things occurred which greatly enhanced my mathematical development:

1) Bob told me about his work with Kari Vilonen, in which they characterized perverse sheaves on a line in terms of two vector spaces and maps

between them. Using this description, Bob showed me that what Siersma's result excluded was the possibility that the vanishing cycles were the direct sum of a shifted constant sheaf, of rank one, on a line plus a summand supported only at the origin. After this conversation, I thought possibly - but did not quite conjecture - that, more generally, the vanishing cycles could never be a direct sum, regardless of the ranks, except in trivial cases.

2) Bob suggested that, in addition to looking at the vanishing cycles, I should also look at the nearby cycles, because the nearby cycles carry more structure. He then explained Gabber's result on the semi-simplicity of the subquotients in the nilpotent filtration of the nearby cycles.

3) Bob gave me one of his last copies of his paper "Global Questions in the Topology of Singular Spaces". What an amazing paper! To this day, I have never read a better expository mathematics paper. The paper contains very high-level mathematics, but is written so beautifully that it literally became bedtime reading for me. This was the first place where I saw the true importance of intersection homology, where I first understood the characteristic cycle, and where I first appreciated the Decomposition Theorem of Beilinson, Bernstein, and Deligne.

I have worked extensively with perverse sheaves, nearby and vanishing cycles, and the characteristic cycle ever since that conversation. And yet, it was not until 16 years later that Lê and I finally proved that the vanishing cycles cannot be a direct sum except in trivial cases. It seems fitting that our paper on this problem appears in these special volumes dedicated To Bob MacPherson.

*According to Arun Ram*:

Bob Macpherson gave me encouragement and attention at a crucial stage of my career. Unfortunately there is no formal mechanism for properly measuring the worth of this type of service to the future of mathematics and there are not proper ways to properly thank him for his small actions that meant so much to us.

I remember one "anecdote". During my years at Princeton Bob gave a couple of beautiful courses on Combinatorial Intersection Homology and on Flag varieties and Loop Grassmanians. The usual method was to spend the hour drawing a beautiful picture of an example (cone ... of a suspension ... of a two banana space... or something like that), and we proceeded through the subject in this fashion. At some point, one of the students in the class, struggling to get a handle on all this stuff asked if we could have a few more precise definitions and precise statements of theorems. Bob said, "Yes, absolutely, you are right that we should try to do that." and then proceeded by writing on the board "Theorem. Let X be a topological spa.." explaining as he went. He got as far as ".. topological space. Let P be" and then said "Let me draw a picture." During the process of drawing the picture the story unfolded in its usual beautiful fashion and writing the precise statement of the theorem disappeared somewhere in some link at a singularity.

*A former graduate student at Brown Paolo Aluffi wrote*:

He had a formidable reputation at Brown among the graduate students, who recounted episodes such as having stepped into his office as he was deeply immersed into J.S.Bach's St. Matthew passion. Others will tell you about his Monday night seminar at Brown, which managed to fill a good-size room with mathematicians from Brown and the Boston area in spite of starting at 9 pm or some such time. I have a fond memory of one my last evenings at Brown, as I was alone in the computer room and MacPherson came in. Mark McConnell had trained the department's Symbolics machine to play music, provided the user had the patience to input it note-by-note in a strange, ad-hoc language. Mark and I had thus input several pieces of music (a few fugues by Bach, some Debussy...), and Bob MacPherson and I spent some time listening to them and chatting about music and math.

*According to Anatoly Libgober*:

I did meet Bob several times on various meetings and we did talk several times but I was most influenced by his thoughtfull and direct lectures and papers. As for specifics: I think it would be good to mention (for example in describing how wide was Bob's influence) that his and (M.Goresky) problem on possibility to define Chern classes or numbers of singular varieties via small resolutions was very important in B.Totaro thinking on elliptic genera (I am sure Burt can confirm this) and certainly in my own thinking which led to a series of our joint papers with Lev Borisov (in Invent, Duke and Annals).

*A fellow student at the graduate school at Harvard, Richard Stanley recalled*:

I actually didn't have much contact with him in graduate school. I was part of a group of students who hung around the common room (at the old Math. Dept. location of 2 Divinity Avenue, which we shared with the Yenching Library). We spent a lot of time playing bridge, blitz chess, air hockey, etc. We also played a lot of frisbee, squash, and raquetball. But Bob did not participate in these frivolous activities. If I remember correctly (you should have this confirmed if you plan to mention it) he built his own harpsichord[14] when he was a graduate student.

Many of the math graduate students at Harvard were actively involved in protesting the Vietnam War. Again I was involved with some other students that did not include Bob, and I can't remember to what extent Bob participated in antiwar activities.

*Frances Kirwan wrote*:

Although of course I have known Bob MacPherson's work for a very long time, and it has had a huge and immeasurable impact on the area in which I work, I have in fact only met him on a few occasions. So I don't think I can contribute anything very appropriate to the article ...

# 4 In the eyes of colleagues

*Robert Langlands, his colleague at IAS, wrote*:

MacPherson is a mathematician I admire greatly, for his geometric insight and for his broad and generous views on the mathematics of others, both young and old. He is also an ideal colleague, industrious, thoughtful, wise and of course congenial.

*His colleague at MIT Victor Guillemin commented*:

Not only have I known Bob for a long time, but his work has heavily influenced my own work and that of my students. However, in the "paragraph" you asked me to write I'll talk about another aspect of Bob: his unorthodox approach to teaching advanced graduate courses. He taught several such courses while he was here at MIT, and I attended most of them. The most formidable of these was a course on the Baily-Borel compactification of locally symmetric spaces. This is probably the most technically daunting topic in all of mathematics, but Bob approached it in a way that minimized the technical complications and made transparantly clear what was really going on. (In fact even a bright undergraduate could have followed most of the details of this course.) Each morning he would arrive in class with a handful of colored chalks and proceed to draw lattices on the blackboard. The problem he urged us to try to solve on our own in two and three dimensions (with a few hints from him) was the classification of these lattices up to rotations. Without mentioning $K\backslash G/\Gamma$ he led us through this classification problem and the compactification of $SO(3)\backslash SL(3,R)/SL(3,Z)$ in an utterly intuitive

[14] According to Bill Fulton, it was actually a clavichord.

jargon-free way and without invoking any fancy high-powered mathematics: no Harish-Chandra structure theory, no adeles, no relative Weyl groups, no anything. It was one of the most beautiful feats of mathematical exposition I'd ever seen.

*Another colleague at MIT Sigurdur Helgason wrote*:

Thank you for your letter. It is nice you are honoring MacPhearson in this way. We of course overlapped for a few years (6-7) at MIT and I was very sorry when he left for the Institute because he was a splendid colleague; very succesful at inspiring students and nurturing their talent.

*His colleague from the Brown years Paul Baum described those days*:

Somewhere towards the end of the sixties, I was in Bott's office discussing foliation singularities when a tall, thin, shy graduate student came into the office. "Professor Bott," he said, "where should I apply for a job?" Almost as a reflex, I said: "Apply to Brown". "Yes," Bott said (with a very slight hint of reluctance in his voice): "Apply to Brown."

So Bob MacPherson came to Brown, followed in the next few years by Bill Fulton, Joe Harris, Dick Gross, and Jean-Luc Brylinski as faculty, and Mark Goresky, as a graduate student. Bob interacted with everybody. With Mark Goresky he began the long collaboration that resulted in intersection homology. With Bill Fulton he used deformation and Chern class methods to solve problems in enumerative geometry. With Bill Fulton and me he developed Riemann-Roch for singular varieties. With Jean-Luc Brylinski and me he defined delocalized equivariant cohomology.

One of the highlights of each week was the MacPherson seminar. Typically the speaker would give a one-hour lecture in the late afternoon. Then we would reconvene after dinner for questions and discussion. When Bob became interested in a particular subject (e.g. the dilogarithm and algebraic K-theory), he would organize an extended weekend of lectures and problem sessions on the topic at hand. These occasions were great fun.

Throughout all this mathematical activity, Bob maintained a cheerful and friendly manner that was encouraging and inspiring. He devoted a great deal of attention to graduate AND undergraduate students - thus providing living proof that there is no inherent contradiction between top-quality mathematical research and excellent teaching.

In the Brown mathematics department during those years there was a wonderful feeling of discovery and creativity. Bob was the leader, the central figure. When I think back on this period I remember it as a Golden Age - and I suspect that Bob MacPherson does too.

## 5 In the eyes of students

*A former student Masaki Hanamura wrote*:

I was a student of Bob's from 1986-1988. I received immense influence from him, mathematically and personally. At that time I was a baby mathematician ( if I am a child mathematician now, hopefully), so the influence was like the from a father. I observed some of the instances where mathematics was being created by him. He showed me how to view an area of mathematics like a piece of work of art, so to speak. He told me how Russian mathematicians work– although I have never been to Russia, I feel as though I could see how they had seminars.

*Richard Scott recalled*:

Others will be able to comment better than I on Bob's contributions to mathematics. And I am sure others will also comment on his very visual and geometric approach to the subject. His ability to find a concise way to organize and visualize even the most abstract theorem is incredible, and although his students efforts to emulate his talent usually fall short, we are all better teachers and mathematicians for having tried.

In my fourth year as a graduate student at MIT, I was just about to start writing up my thesis when a very closely related paper (with substantial overlap) by Mike Davis and Tadeusz Januszkiewicz was accepted by the Duke Journal. Bob's handling of the situation had a tremendous impact on my future as a mathematician. It is a good example of his skill at mentoring young mathematicians and shows his dedication to his students. His first comment, after acknowledging the inevitable disappointment, was to put a positive spin on it: "this means that there are people out there who are interested in this circle of ideas" (from which I inferred this is not always the case for Ph.D. theses). And then he suggested two options. I could finish writing up my thesis and have no contact with the article (or its authors) and finish at the end of the year, OR I could work a little longer, try to get some new results, and talk to the authors in the meantime. The first option was the psychological panacea ("you've done enough to finish"), the second option was the loaded one ("but if you want to succeed as a mathematician you need to be an active part of the mathematical community"). Needless to say, I chose the second option and Mike and Tadeusz and I have had a very fruitful collaboration ever since.

*Julianna Tymoczko wrote*:

Like many others, I am struck by the manifest delight that Bob takes in mathematics: he seems to play at math as much as he works at it. Bob is one of the only people I've ever met who will laugh at a piece of mathematics, much the way another person might laugh at a kitten or at a surprise party. Many people will testify to his encouragement of young scholars. I have always felt that characteristic stems from the genuine interest and pleasure that he takes in others' work. As his graduate student, I found that interest to be the best kind of support I could have received.

*According to Tom Braden*:

One of the things that has always impressed me about Bob is the amount of time, energy, and thought that he spends helping young mathematicians, not only his students and the postdocs at the institute, but more generally. This extends from ideas about graduate education and structuring the job market to the architecture and furnishing of math departments. I made my earliest forays into mathematical research as a graduate student in long hours on a comfortable couch in the back corner of the MIT reading room, which I later found out was there thanks to Bob.

Talking mathematics with Bob, both as his student and as his collaborator, is not like any other math conversations I have had. I was lucky that shortly after I became his student, Laura Anderson advised me not to jump in when he fell silent, but to wait and see what happened. Sometimes in the deepest parts of a math conversation his silences will stretch for several minutes, while he struggles for the right words to express an idea. In my experience, it is nearly always worth the wait.

One thing I learned to appreciate from our conversations is that finding the right example or picture or point of view can be as important as proving a theorem: given the right perspective, the theorems often follow, although not always quickly. One of my papers which I am proudest of was joint work with Bob which sprang from conversations we had back in graduate school. We had a clear idea that it should be possible to extract a computation of intersection cohomology from a certain graph. After many happy hours playing with Zometools models we were convinced it could be done, but the key idea to complete the proof didn't appear until five years later.

*Many stories and jokes about Bob circulated among his students have been collected by Paul Gunnells. Here is a sample taken from his article.*[15]

[15]**Four short stories about Bob**, delivered by Paul Gunnells at the banquet of the conference in honor of the 60th birthday of MacPherson at IAS, Princeton, October 2004. The full article is available at the home page of Gunnells: www.math.umass.edu/~gunnells

Mark Goresky asked me to deliver some comments at the banquet in honor of Bob's 60th. To me this smelled like a roast. Now, I have no problem with this, since Bob, besides being really smart and all, is actually a pretty colorful guy. I had no trouble digging up lots of fun stories about him; selecting which ones to tell was also easy (I just chose the ones that wouldn't get anyone arrested).

Telling the stories at the banquet to a bunch of half-drunks was a lot of fun; putting them in writing is terrifying. However I have been assured by all involved that no litigation will follow, and that this meets with Bob's approval. I certainly hope so.[16]

**Remark.** Bob was a fantastic thesis advisor, and I owe him an enormous intellectual debt that I can never repay. Working with him opened my eyes to a completely different way of looking at mathematics. He's also a really wonderful person (not to mention a fine chef). I hope that my admiration and respect for him isn't somehow missed in all the silliness below.

### How Bob almost didn't get tenure at Brown

Sometime in the 80s Bob and Mark Goresky were working at Brown. They were writing a long paper, with lots of complicated notation, and were stuck: they couldn't agree what the notation should be in one part of the paper. They argued a lot about it, but neither one was able to convince the other that his way was better.

One night Bob had an idea. There's no diplomatic solution, so perhaps war makes sense. He arrived for their session with two fully loaded water guns. These were the big ones, akin to automatic rifles, not the dinky water pistols most are familiar with. Mark agreed, this is the only way to resolve the conflict, and they both agreed that whoever won got to choose the notation.

The fighting began. It was vicious. Immediately they were chasing each other around the math department; water was everywhere. Pretty soon the reasons for fighting were forgotten, and it became all about destruction of the opponent.

Eventually Bob found himself waiting to ambush Mark at the top of a large stairway. He heard Mark stealthily approaching, and he knew Mark was about to get annihilated. He hid in the shadows until he heard Mark reach the top of the stairs. At the last possible second he leapt into Mark's path and soaked him.

[16] Some details have been embellished.

Unfortunately, the victim wasn't Mark: it was Andrew Browder.

Game over.

(I understand that Prof. Browder found this *not amusing*. However, everything turned out fine, and Bob did get tenure at Brown.)

**Tips for potential students of Bob MacPherson**

Here are some dos and don'ts (mostly don'ts) if you think you want to work with Bob. Some are a bit dated, and apply to Bob's years at MIT. However, they should be easily adaptable to IAS/Princeton.

1. *Don't ever sit in the big chair.* Instead, sit on the couch, unless of course Bob is lying down on the couch. In this case don't sit in the big chair either; just stand uncomfortably near the board.

2. *Bring lots of change for the vending machine.* An essential event in many nights with Bob is the trip to the vending machine, and you don't want to be caught short. There's an enormous Ziploc bag of change hidden in his filing cabinet, but he keeps a sharp eye on it so you'd better bring your own. Also, when at the vending machine, be prepared for him to agonize over his choice for several minutes, and then to select the *same item* each time without fail.[17]

3. *Don't attempt to make an appointment with Bob by telephone, letter, or email.* If you have read *Catch-22* and are familiar with the character Major Major Major Major, then you have some idea of how Bob's appointments process works. A variation on this rule is *If the phone rings in Bob's office while you're with him, don't answer it.* A ringing telephone provokes a reaction in Bob most people reserve for an angry rattlesnake. Just let it ring and sit there with him and watch it.

4. *If he sits several minutes in complete silence, don't say anything.* This is not a good time to make small talk. Also don't try to apply mouth-to-mouth or anything like that. He's fine. Just wait it out. This is also not a good time to root around in the filing cabinet looking for change.

5. *If he leaves the room suddenly without announcement, don't do anything.* Just wait; most likely he'll be back. Indeed, sometimes he will

[17] I don't remember what it was ... Bob claims it was orange juice.

leave in the middle of a sentence, then return ten minutes later to complete the sentence as if nothing happened. It's best to pretend nothing happened. *Exception:* if he doesn't return after half an hour or so, then you have missed the last train to Braintree (and probably Alewife too). Just turn out the lights and lock up on your way out. And this is a good time to get change from his filing cabinet.

6. *The answer to your question is ...* From time to time you will need to ask Bob a question. No matter what your question is, the answer will be one of the following, accompanied by a suitable picture:

   (a) The Whitney cusp

   (b) The pinched torus

   (c) The Grassmannian $G(2,4)$

   (d) The singular Schubert variety in the Grassmannian $G(2,4)$

   (e) A small resolution of the singular Schubert variety in the Grassmannian $G(2,4)$

   (f) The hypersimplex $\Delta(2,4)$

   (g) Langlands duality (yes, he can draw a picture of this)

   You will notice that his answer doesn't answer your question. In fact, after reflection you will realize that his answer answers the *question you should have asked*, and it is your task to determine this question.[18] This will happen over and over again for several years, with the time it takes you to figure out the correct question regularly decreasing. When you reach the point when you can figure out the correct question on your own without having to ask him, then it is time to graduate.

7. *Under no circumstances should you imitate Bob in matters of dress or when you give a talk.* No beards, no Tevas with socks.

8. *Parting advice.* Here are some quick tips taken from real life experiences of real life Bob students:

   (a) Don't leave your thesis in your car (it might get stolen).

[18] Which is absolutely the correct question, and which his answer answers correctly.

(b) Make sure that when you submit your thesis it includes an introduction and uses verbs.

(c) Don't make an appointment with your advisor in a foreign country and then show up 2 1/2 months late. A variation: don't go on sabbatical with your advisor and spend the entire time playing piano in nightclubs.

(d) Make sure your thesis hasn't already appeared in an obscure journal like *Mathematische Annalen* or *Duke*.

(e) Never refer to any mathematical problem by "But it's *just combinatorics*."

(f) Finally, never agree to give remarks like this at banquet for your advisor.