To Tudor S. Ratiu on the occasion of his 60th birthday

Picture by Peter Michor

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PREFACE

In July 2010 we celebrated the 60th birthday of Tudor S. Ratiu with a workshop entitled "Geometry, Mechanics, and Dynamics" that was held at the Centre International de Rencontres Mathématiques in Luminy. Tudor is one of the world's most renowned and esteemed mathematicians and this conference was a great occasion to go over the numerous subjects on which he has worked and had a deep influence. Most of these topics are strongly connected to the subject matter of this journal, whose very foundation owes much to Tudor's encouragement and support.

I coorganized this event with the late Jerry Marsden who was the main force behind it and started its preparation several years in advance as it was his habit with so many other things. Jerry was not only Tudor's PhD advisor but also his main collaborator for thirty years, friend, mentor and as for many of us, an endless source of intellectual inspiration. This is why we felt so sad when we learnt that his health had deteriorated and that he could not attend the meeting he had put so much dedication on and, needless to say, so devastated when the news of his passing arrived a few months later.

The meeting lasted an entire week and the program was intended to represent the topics to which Tudor has successfully dedicated hard work, boundless energy and ceaseless enthusiasm, essential traits of his personality that we have all enjoyed over the years. This special number of the Journal of Geometric Mechanics is the first of a series that aims at the same goal and collects some of the works presented during the conference, most of them written by people who have worked with Tudor for many years. In general lines, most talks were related to the following subjects:

- Integrable systems: this is the first mechanics related topic that Tudor worked on in his career. Already, his thesis dealt with the integrability of n-dimensional rigid bodies and he has ever since actively participated at the development of this field, especially in problems in connection to deep Lie theoretical questions.
- Mechanical systems with symmetry: this is the subject that from the point of view of work volume has received most attention by Tudor and puts together two of his lifelong passions: mechanics and Lie Theory. The beginning of Tudor's career in Berkeley took place at a time in which major advances in this field saw the light. For example, the 1974 Marsden-Weinstein paper on symplectic reduction had just appeared; this piece of work connects previous ideas of Jacobi, Smale, Arnold, and other great masters in a context where the relationships between symmetry, conservation laws, momentum maps, and geometric and dynamic reduction are depicted in a beautiful and categorically natural setup. Tudor has contributed massively in developing and exploiting the far reaching implications that this circle of ideas has as to the existence, bifurcation, and stability of various types of symmetric (also called relative) solutions, both in the finite and infinite dimensional contexts. Personally, these topics are of particular significance to me, as they were the subject of my PhD thesis written under Tudor's supervision, and later on the content

of many papers that we have written together as well as of a couple of books that we have coauthored.

- Infinite dimensional geometric mechanics: fluids, plasmas, liquid crystals, and other infinite dimensional systems have been a playground of preference for Tudor as to the questions described in the paragraph above. It is impressive how over the years Tudor became simultaneously an expert not only on the geometric formulation and properties of these systems, but also on the difficult functional analytical techniques needed to handle them, and on the applications of the important results that he obtained over the years. In this respect, his friendship and collaboration with Darryl Holm was determinant.
- Symplectic and Poisson geometry and Lie theory: the roots of the interest of Tudor for symmetric mechanical systems lay at his fascination for the rich interplay between these two categories whose foremost byproduct is the theory of momentum maps, placed at the center of so many of his works. The importance of symplectic and Poisson geometry in Tudor's career is again a natural consequence of his raising as a mathematician in Berkeley in the 80's; his interest for Lie theory predates his arrival to the US and is already the subject of a book in Romanian that he wrote with Burghelea and Albu as an undergraduate student. Later on there would be influential encounters with Bertram Kostant, a constant reference for him, as well as fruitful collaborations with Hermann Flaschka. More recently, he has been part of interesting generalizations of these fields that are seeing much activity in the last years; for example Dirac manifolds and Lie groupoids and algebroids.

There are many other families of topics that have also been at the heart of Tudor's activity that even though will not be described here in detail, were present in one way or another at the RatiuFest: geometric control theory, field and gauge theories, elasticity, Teichmüller theory, convexity properties of the momentum map, infinite dimensional Poisson geometry, the n-body problem, celestial mechanics, general dynamical systems, partial differential equations, and numerical methods for the integration of mechanical systems.

Most speakers at the conference tried to put the work they presented in context and to show its connections to Tudor's interests and contributions. Even though for most of us it was already known, by the end of the week, these talks clearly evinced the depth and magnitude of the impact of his work. This statement is not just a subjective perception; indeed, it is easy to get a grasp of Tudor's intellectual influence just by looking at a few numbers. For example, to this day MathSciNet shows 2048 citations of his 175 publications by 1287 authors which is exceptionally high.

The reasons for the significance of Tudor's work are not only based on its quality or on the good mathematical taste behind his choices, but also on the pedagogical qualities of the author. All those who attend one of his courses or talks remember it as a remarkable event and are captivated by his boundless display of energy and enthusiasm. This oral pedagogical talent has a counterpart when it comes to writing: in addition to the 170 papers in his publication list, he is the author of seven books that are considered the main reference in their field. For example, he collaborated with Ralph Abraham and Jerry Marsden in the writing of the second edition of "Foundations of Mechanics" which is by far the most quoted reference in this discipline. Years later, already in the 90's he wrote with Jerry Marsden "Introduction to Mechanics and Symmetry" (IMS) that has already been translated

to German and Chinese and is used by thousands of students all over the world as the main entry door into this topic. It makes no doubt to me that this success is based on Tudor's attractive expository style that makes no concession to the lack of detail, correctness, or clarity. A few years after IMS, I wrote with him our monograph on momentum maps and Hamiltonian reduction; it took us ten years to finish the project but I had the privilege to learn first hand the care, patience, and thoroughness necessary to ensure the quality level that has made Tudor's work so popular and influential.

At a more personal level, Tudor has been for years a pronounced source of intellectual inspiration for those of us who have had the chance to be his collaborators and/or students (18 to this day). Tudor is a restless traveller and has the talent to be able to efficiently collaborate with people from all cultural and intellectual horizons. The intrinsic nature of science is based on establishing connections between different circles of ideas; that is why Tudor's willingness to put these abilities at the service of knowledge has had so fruitful results.

We hope that the articles contained in these special numbers dedicated to Tudor Ratiu's 60th birthday celebration give the reader an appreciation for the importance of his contributions to the fields at the core of this journal and give him also a feeling of the immense pleasure that we had to celebrate Tudor as a teacher, colleague, and friend at the RatiuFest.

Juan-Pablo Ortega
Guest Editor