TUDOR RATIU

Tudor Ratiu is chaired professor of mathematics at the Shanghai Jiao Tong University, emeritus professor of mathematics at the Ecole Polytechnique Federale de Lausanne, and emeritus professor of Mathematics at the University of California at Santa Cruz. He obtained his M.A. in mathematics at the University of Timisoara in 1974, and his Ph.D. in mathematics at the University of California at Berkeley in 1980, under the supervision of Jerrold E. Marsden. After several assistant and associate professorships in prestigious USA Universities, he got a professorship at the University of California at Santa Cruz in 1988, where he stayed up to 2001. In 1998 was appointed chair professor of geometric analysis at the Ecole Polytechnique Federale de Lausanne. In the period 2002-2014 he was director of Bernoulli center at the Ecole Polytechnique Federale de Lausanne. From 2014 to 2015 he was professor of mathematcs and director of the center of mathematical sciences at Skolkovo Institute of Science and Technology.

He is the author of more than 230 research paper and 9 books. He has been the recipient of several awards and honors, like *the Humboldt Senior Professorship Prize* (1997), the award of the *Romanian Academy for excellence in research and collaboration with Romania* (2009), and the award of *Excellence in Sciences from the American-Romanian Academy of Arts and Sciences* (2015).

Most of his research activities was centered on both geometric classical and continuum mechanics and nonlinear global analysis.

In particular, he has given several original contributions in the noncanonical Hamiltonian structures, nonlinear stability, and bifurcation theory framework. Conservative systems of ordinary and partial differential equations appearing in mathematical physics and as examples of completely integrable systems are naturally Hamiltonian in a noncanonical structure. These Poisson structures are intimately tied to the theory of Lie algebras, symplectic geometry, and the theory of connections on fiber bundles. The interaction between these fields of pure mathematics and questions arising naturally from applied mathematics and physics is a very fertile ground of research. For example, these Poisson structures form the geometric framework in which new criteria for nonlinear stability of relative equilibria can be proven. One obtains in this way bounds guaranteeing the stability of specific solutions.

By violating these bounds, bifurcation phenomena appear that can be treated by the same geometric techniques. Furthermore, perturbing the system by the addition of dissipation in the internal variables results in instability of the relative equilibrium, thereby showing that the stability criteria are sharp. The same geometric setup also enables the computation of additional phases in the dynamics of these systems, a phenomenon appearing in both classical and quantum mechanics.

Tudor Ratiu was also interested in complete integrability theory. In the theory of conservative systems of ordinary and partial differential equations there are special cases that can be explicitly solved. This is a rare occurrence and is intimately related to the underlying differential geometry of the problem. Such systems have a high degree of symmetry that enables one to closely tie their dynamic behavior to the theory of Lie groups and Lie algebras. The symmetry of these systems implies the existence of a large number of conserved quantities, equal, in fact, to the number of degrees of freedom. The collection of these functions has remarkable convexity properties that are in turn related to Lie group actions on symplectic manifolds. The interplay between dynamics, geometry, and convexity is an area of great current interest. For example, results in convex analysis give unexpected insight into the Lie theory of diffeomorphism groups and the nature of solutions of certain highly nonlinear partial differential equations.

Finally, he has worked in the infinite-dimensional manifolds and Lie groups theory. In geometry and mathematical physics one often deals with symmetry groups that are not Lie groups in the usual sense. Such groups are usually formed by diffeomorphisms or operators of finite differentiability class (for example, groups formed by diffeomorphisms preserving a special structure, or groups of Fourier integral operators on a compact manifold). These groups turn out to have the structure of a topological group and of a smooth infinite-dimensional manifold. However, only right translation is smooth. Taking the inverse limit with respect to the differentiability class, a Lie group–like object is obtained. It is of great interest to study these groups from the point of view of Lie theory, to explore their structure and its relationship to the topology of the underlying manifold, or to consider actions of such groups on infinite-dimensional manifolds appearing naturally in mathematical physics or geometry.

Among his vast original and high-impact scientific production some remarkable publications may be highlighted:

- Marsden, J.E., T.S. Ratiu, and S. Shkoller, *The geometry and analysis of the averaged Euler equations with normal boundary conditions,* Geometric and Functional Analysis, 1999.
- Castrillón-Lopez, M., T.S. Ratiu, and S. Shkoller, *Reduction in principal fiber bundles: covariant Euler-Poincaré equations,* Proc. Amer.Math. Soc., 1998.

- Ortega, J.-P. and T.S. Ratiu, *Singular reduction of Poisson manifolds*, Lett. Math. Phys., 46, 359-372, 1998.
- Marsden,. J.E., G. Misiolek, M. Perlmutter, and T.S. Ratiu, *Symplectic reduction for semidirect products and central extensions*, Diff. Geom. and its Appl., 9, 173-212, 1998.

Tudor Ratiu's contributions are always characterized by original and fruitful points of view that have led to fundamental advancements in Mathematics with several consequences in our understanding of fundamental Physics.

For all exposed reasons the committee, entrusted by the Scientific Committee of the International Research Center MEMOCS with the responsibility of awarding the International Levi-Civita Prize, unanimously proposes Professor Tudor Ratiu as recipient of the 2016 edition.