Prof. Michael Heller
Professor

Most important awards, prizes and academies

Awards: Zonn Medal, Polish Astronomical Society for the popularization of science (1986); Templeton Prize (2008). *Academies*: Ordinary member, Saint Petersburg Academy of the History of Science and Technology (1998); Pontifical Academy of Sciences (1990). *Honorary Degrees*: Technological University A.G.H., Cracow (1996).

Summary of scientific research

In the early seventies Prof. Michael Heller studied, as one of the first cosmologists, relativistic world models with bulk viscosity dissipation. Now such models are considered to be standard, and bulk viscosity is interpreted as due to various quantum and semiquantum effects (e.g. the creation of particles in a strong gravitational field). Heller also investigated the influence of bulk viscosity in the appearance of singularities in cosmology. He has always been interested in the problem of classical singularities in relativistic physics. It turned out that to cope with this problem one has to generalize the standard concept of smooth manifold. To this end, Heller and his co-workers developed the theory of differential spaces and later on (with W. Sasin) the theory of structured spaces. Both these theories, by using algebraic methods, generalize the standard differential geometry to various 'pathological' situations. It turns out that different kinds of singularities met in general relativity can be investigated with the help of the theory of structured spaces. Although in

the case of the most malicious singularities this methods fails to be adequate, it at least explains the source of the problem. Happily enough, even the most malicious singularities surrender to the methods based on so-called non-commutative geometry. These methods have been adapted and successfully applied to the singularity problem in general relativity by Heller and Sasin. The generalization of Einstein's general relativity in terms of structured spaces (the so-called Einstein algebras) has also been worked out. By changing from commutative Einstein algebras to non-commutative Einstein algebras, one obtains the version of general relativity expressed in terms of mathematical structures which are very close to those used in quantum physics. Following this similarity, Heller and Sasin have proposed a model, based on non-commutative geometry, unifying general relativity and quantum mechanics. This model explains surprisingly well several non-local phenomena met in cosmology and quantum physics. M. Heller has written several books and about 700 papers on the history and philosophy of modern physics, and the relationship between science and theology.

Main publications

Heller, M., *Questions to the Universe - Ten Lectures on the Foundations of Physics and Cosmology*, Pechart Publishing House (Tucson, 1986); Heller, M., *Theoretical Foundations of Cosmology - Introduction to the Global Structure of Space-Time*, World Scientific (Singapore-London, 1992); Heller, M., Klimek, Z. and Suszycki, L., Imperfect Fluid Friedmannian Cosmology, *Astrophysics and Space Science*, 20, pp. 205-12 (1973); Heller, M. and Klimek, Z., Viscous Universes without Initial Singularity, *Astrophysics and Space Science*, 33, L37-L39 (1975); Gruszczak J., Heller, M. and Multarzynski, P., A Generalization of Manifolds as Space-Time Models, *Journal of Mathematical Physics*, 29, pp. 2576-80 (1988); Heller, M., Algebraic Foundations of the Theory of Differential Spaces, *Demonstratio Mathematica*, 24, n. 3-4, pp. 349-64 (1991); Heller, M., Einstein Algebras and General Relativity, *International Journal of Theoretical Physics*, 31, pp. 277-8 (1992); Heller, M. and Sasin, W., The Structure of the b-Completion of Space-Time,*General Relativity and Gravitation*, 26, pp. 797-811 (1994); Heller, M. and Sasin, W., Sheaves of Einstein Algebras, *International Journal of Theoretical Physics*, 34, pp. 387-98 (1995); Heller, M. and Sasin, W., Structured Spaces and Their Application to Relativistic Physics, *Journal of Mathematical Physics*, 36, pp. 3644-62 (1995); Heller, M. and Sasin, W., Non-Commutative Structure of Singularities in General Relativity, *Journal of Mathematical Physics*, 37, pp. 5665-71 (1996); Heller, M. and Sasin, W., Groupoid Approach to Non-commutative Quantization of Gravity, *Journal of Mathematical Physics*, 38, pp. 5840-53 (1997); Heller, M. and Sasin, W., Origin of Classical Singularities,*General Relativity and Gravitation*, 31, pp. 555-70 (1999); Heller, M., *The World and the Word*, Pachart Publishing House (Tucson, 1986); Heller, M., *The Morality of Thinking*, Biblos, (Tarnów, 1993) (in Polish); Heller, M., *The New Physics and a New Theology*, Vatican Observatory Publications (Vatican City State, 1996); Heller, M., *To Grasp the Transient Moment*, Znak (Cracow, 1997) (in Polish); Heller, M., *Happiness in the Banach Space*, Znak (Cracow, 1997) (in Polish); Heller, M., *Is Physics an Art?*, Biblos (Tarnów, 1998) (in Polish); Heller, M., Time of the Universe, *The Far-Future Universe - Eschatology from a Cosmic Perspective*,

(G.F.R. Ellis, ed.), Templeton Foundation Press, Philadelphia - London, 2002, pp. 53-64; Heller, M., Odrzygózdz, Z., Pysiak, L., and Sasin, W., Structure of Malicious Singularities, *International Journal of Theoretical Physics*, 42, pp. 427-41 (2003); Heller, M., *Creative Tension - Essays on Science and Religion*, Templeton Foundation Press (Philadelphia - London, 2003); Heller, M., *Some Mathematical Physics for Philosophers*, Pontifical Council for Culture, Gregorian University (2005); Heller, M., *A Comprehensible Universe: The Interplay of Science and Theology* (Springer Verlag, 2008) with George Coyne; Heller, M., *Ultimate Explanations of the Universe* (Universitas, in Polish, forthcoming).