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Introduction

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Abstract

While the importance of magnetized plasmas for the physics of stars and star formation is reasonably well established, an ongoing topical debate discusses their role in larger cosmic structures such as galaxies. Here an enormous diversity of complex plasma processes governs the structure and evolution of interstellar gas.
These proceedings summarize a meeting intended to provide a broad interdisciplinary forum gathering specialists from various fields in plasma- and plasma-astro-physics to address the importance of the magnetized plasma in galaxy evolution.

1 The place

For the "young" Ruhr-University in Bochum, founded in 1965, the partnership with the "old" Jagiellonian University in Kraków, first founded in 1364, already has its tradition. Such partnerships live, of course, from the collaboration in science and education. Scientists and graduate students in the physics and astronomy departments in Kraków and Bochum are enjoying for many years an intensive exchange and for the astronomers and astrophysicists participating in this partnership the role of magnetic fields on galactic scales has been one of the guiding questions.

It was this common interest for the specific scientific question which led to the idea of this conference. The long tradition in astronomy at the Jagiellonian University – with Copernicus being one of the most famous early students – seems to be just the right place to also address topical problems in today's astronomy. And the conference center of the university near the castle of Przegorzały overlooking the Vistula river valley provides the remoteness required and convenience needed for a successful scientific meeting.

2 The topic

Cosmic magnetic fields are currently a very topical issue and they were discussed during the year 2004 in a number of international conferences. In more general terms magnetic fields in the cosmos, from Big Bang to compact objects, were addressed at the Brazil meeting on "Magnetic fields in the Universe" (Dal Pino et al. 2005). The role of magnetic fields in the large scale structure and its formation was discussed in Korea under the title "Cosmic rays and magnetic fields in large scale structure" (Ryu & Kang 2004.) The magnetic field in the interstellar medium also played a central role at the Arecibo meeting "Diffuse matter in the Galaxy: observations confront theory" (Chu et al. 2005) honoring Carl Heiles and the influence of the magnetic field on cosmic rays was discussed in a workshop on "Cosmic ray dynamics: from turbulent to Galactic-scale magnetic fields" in Copenhagen. Similar to the meeting summarized in this book was the workshop at the Lorentz Center in Leiden.

This remarkable number of meetings – within only one calendar year – focusing on cosmic magnetic fields clearly demonstrates how vital the question of generating and sustaining them is in astrophysics. The quest for the origin of cosmic magnetic fields, however, should be considered of even more general importance and is becoming a topic for fundamental physics, too. This is clearly indicated, e.g., in the discussions on science drivers for the next generation radio telescopes. For the Square Kilometer Array (SKA) the "Magnetic Universe" is considered to be one of the five most important key-science questions (Carilli & Rawlings 2004).

Evidence for a link to other fields in physics also comes from new and larger initiatives relating questions in plasma-astrophysics to laboratory-plasma physics. Since most of the observable baryons in the universe are in the plasma state studying interstellar plasmas in galaxies is not only important for the understanding of galaxy evolution, it also provides an unique laboratory of great value for plasma physics in general. It allows us to investigate processes in magnetized plasmas in conditions not accessible in terrestrial laboratories. Here the Collaborative Research Center (Sonderforschungsbereich, SFB) of the German Science Foundation (DFG) at the Ruhr-University should be mentioned. Under the general topic "Universal behaviour of plasmas far from equilibrium: heating, transport and structure formation" (SFB 591) also magnetized plasmas under laboratory and in astrophysical situations are studied. The "Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas (CMSO)" jointly run by six different US institutions is a very similar inititiative funded by NSF.

3 The scope

While the topical debate on the role of magnetic fields in larger cosmic structures has just started, it seems that the importance of magnetized plasmas for the physics of stars and for the star formation process is reasonably well established. For the interstellar (and intergalactic) medium an enormous diversity of complex plasma processes governs the structure and evolution of the gas (see, e.g. Bregman 2004) and in order to deal with relevant questions, a combination of all these aspects is required to expand the knowledge of people working in the field of modern plasma physics.

These proceedings summarize a broad interdisciplinary approach contributed by specialists from various fields in plasma- and astro-plasma-physics with relevance for magnetic fields on galactic scales. These include, among others, the role of the magnetization of the interstellar medium in cloud and star formation; structural changes of the magnetized ISM in the peculiar flows induced by spiral arms, bars and interactions; the role of magnetic fields in structuring the ISM and in providing sources of heating and ionization in the ISM, the creation of seed fields – and other present issues not fully understood.

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