MAGNETIC FIELDS THROUGHOUT STELLAR EVOLUTION

IAU SYMPOSIUM No. 302

COVER ILLUSTRATION:

Numerical dynamo in a rapidly-rotating spherical shell that models the magnetism of an active fully convective M dwarf. Due to the ordering influence of the dominating Coriolis force, convection develops as large scale convective columns that maintain the dynamo action. The surface topology of the magnetic field is dominated by its dipolar component. At depth, the magnetic field lines show a more intricate structure. The color of the field lines scale with the amplitude of the radial component of the magnetic field (red outward, blue inward) and the surface is made transparent to highlight the magnetic field structure at depth. Credits: Thomas Gastine

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MAGNETIC FIELDS THROUGHOUT STELLAR EVOLUTION

PROCEEDINGS OF THE 302nd SYMPOSIUM OF THE INTERNATIONAL ASTRONOMICAL UNION HELD IN BIARRITZ, FRANCE AUGUST 25–30, 2013

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Session 3: Origin and impact of magnetic fields in higher-mass stars with radiative outer layers

Foreword

All phases of stellar evolution are influenced by the presence of magnetic fields in the interior and close environment of stars. Magnetic fields play a central role in the spindown of young stars, through magnetized outflows, star-disc interaction or magnetically-driven winds. They also impact the vertical settling of chemical species, leading to abnormal surface abundances observed in stars more massive than the Sun. In the advanced phases of stellar evolution, magnetic fields influence stellar evolution through their contribution to the mass-loss of cool giants and supergiants. Finally, extreme magnetic fields are observed in a small fraction of compact stellar remnants, powering X-ray and gamma ray emission.

Although most of these points have been identified decades ago, the ability to measure stellar magnetic fields and incorporate them in stellar models is relatively new. In this young and still growing research domain, the last few years have seen the dawn of a new era, with the advent of powerful tools strengthening both observational and modelling approaches to this field, rapidly changing our view of stellar magnetism throughout stellar evolution. The aim of this symposium was to bring together colleagues from all of these research areas. The topics covered spanned all phases of evolution, from the formation of stars and their early accreting years, through main sequence evolution for both low and high mass stars, and also the final stages of stellar evolution. Much of stellar astronomy now has relevance for the new field of exoplanets, and this brought another community to the symposium.

In addition to synthesizing the expertise of many research areas, the symposium also provided a forward look to the challenges and opportunities of the forthcoming decade. With an increasing number of present or future ground-based instruments in the visible and near infrared domains, stellar spectropolarimetry is now delivering direct magnetic field measurements throughout most of the Hertzprung-Russell diagram. Combined with tomographic modelling, spectropolarimetric data sets provide the surface distribution of the magnetic vector with increasing spatial and temporal resolution. Many indirect tracers of magnetic activity are also available from X-rays to sub-millimetric and radio wavelengths, providing us with observational clues on the effect of magnetic fields at various distances from the stellar surface (chromosphere, corona, accretion flows, winds, jets). Statistical studies based on huge samples are also obtained from space-borne observatories like KEPLER, offering a completely new view of stellar activity. They will soon be complemented by systematic activity measurements provided by the GAIA spacecraft. This wealth of observational material is progressively getting closer to the richness of solar observations, for which continuous monitoring is now available at extremely high spatial resolution and throughout most of the electromagnetic spectrum (e.g. HINODE, SDO). This symposium showed clearly that these tight observational constraints constitute a necessary guidance to numerical simulations of stellar magnetism, which now use the power of massively parallel supercomputers, enabling the investigation of stellar dynamos through global 3-D simulations of convective layers, as well as the evolution of magnetic fields in radiative zones. The future indeed promises to be a rich one for studies of stellar magnetism throughout stellar evolution.

Pascal Petit, Moira Jardine & Hendrik Spruit

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