INAF – ISTITUTO NAZIONALE DI ASTROFISICA
Progetti di ricerca di rilevante interesse nazionale
Bando PRIN-INAF 2010

Title of the research project:
Magnetic fine structure of the solar atmosphere

Thematic Macroareas:
M3. Sun and Solar System (100%)

Large Programs:
Not applicable for solar observations.

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1. Summary

Magnetism on the Sun occurs on all scales. It manifests itself at the largest scales as a mean field component that covers the entire hemisphere, and on progressively smaller scales as active regions, sunspots, and pores. As we resolve ever smaller structures in the lower solar atmosphere, it has become clear that magnetism is an important component of those small structures. High-resolution observations, theoretical arguments, and numerical simulations indicate that the small-scale magnetism holds the key to many poorly understood facets of the solar magnetism on all scales, such as the existence of a local dynamo, chromospheric heating, and flux emergence, to name a few. As a comprehensive model of the interaction of magnetic field, hydrodynamics, and radiative transfer leading to the magnetic activity is currently impossible from a practical standpoint, to gain understanding of the physical processes involved in the small-scale magnetism we must turn to observations.

The goal of this proposal is to make substantial advances in the understanding of the role played by the small-scale magnetic structures in some processes occurring in the solar atmosphere, by exploiting the potentialities of combined high-resolution observations and numerical simulations. In particular, we will focus on four topics underlying the evolution of magnetic features and solar irradiance variations. Both subjects figure in the short- and long-term research plans of INAF. The combination of the results expected from state-of-art high resolution multi-wavelength imaging and polarimetry with detailed numerical simulations offer the promise to gain understanding of the physical processes responsible for new observational results obtained during the last two years and still not understood. On the other hand, the proposal also aims at strengthening the know-how gained in the recent years on the analysis of high-resolution observations and on numerical techniques applied for investigating the fine structure and dynamics of the Sun that is depicted by high-resolution ground- and space-based telescopes. In particular, we intend:

1) to analyse the high-resolution spectro-polarimetric solar data derived from complementary new observing campaigns performed with IBIS/DST, CRISP/SST and space-based telescopes;
2) to determine the local thermal structure in different clusters of magnetic field elements, to contribute to assess the role of small-scale magnetic elements in the quiet Sun variability;
3) to measure the radial intensity profile within supergranular cells, to untangle the thermal signal associated with plasma flows and the one derived from unresolved magnetic flux elements;
4) to describe the processes underlying the interaction between new emerging magnetic flux and the pre-existing chromospheric and coronal field;
5) to outline the modalities of the magnetic field diffusion during the final phase of active regions;
6) to investigate the role of the small-scale magnetic reconnection in the heating of plasma in the various regions of the outer solar atmosphere.

The project involves two research units at INAF–OAR and INAF-OACT. The program is based on the collaborative work carried out in the recent years for the study of the processes occurring at the smallest spatial scales in the solar atmosphere, as demonstrated by complementary observing campaigns carried out with PRIN-MIUR-04 and PRIN-INAF-07 funds, a few linked publications on the topic, and the joint participation to the scientific and technological activities carried out by international projects for the construction of next generation solar telescopes, as the European Solar Telescope and Solar Orbiter, and of research synergies as to the SOLAIRE network.