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What do we know about the photospheric and chromospheric magnetic field?

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Solar magnetic fields are essential ingredients for the energetics and dynamics of the lower solar atmosphere. After emergence, they continually interact with convective flows and with each other. The resulting field line braiding is believed to trigger magnetic reconnection in the chromosphere and above, generating a wide variety of features and contributing to atmospheric heating, both locally and globally. However, the exact conditions leading to magnetic reconnection are not yet well understood. Also, the origin of the field and the process of flux emergence are poorly known, particularly on the smallest scales.

Determining the topology and energy injected by the fields in the lower solar atmosphere is key to understanding these processes. Significant advances have been achieved through multi-line spectropolarimetric observations at ever increasing spatial resolution. Specific examples will be discussed here. However, the efforts have been hampered by insufficient polarimetric sensitivity, which makes it difficult to follow the evolution of the fields or even detect the weaker ones, particularly in the chromosphere. Thus, a direct confirmation of the scenarios suggested by numerical simulations is not possible in general. The lack of tools to infer the vector magnetic field from spectropolarimetric measurements has impeded progress, too. These limitations will soon be overcome, giving access to the elusive chromospheric fields. The interpretation of the new observations will require simulations of the entire solar atmosphere covering larger fields of view. Together, they will clarify the origin of solar magnetic fields, their structure, and their role in the heating of the solar atmosphere.

Primary author: BELLOT RUBIO, Luis (Instituto de Astrofísica de Andalucía (IAA-CSIC))

Presenter: BELLOT RUBIO, Luis (Instituto de Astrofísica de Andalucía (IAA-CSIC))

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