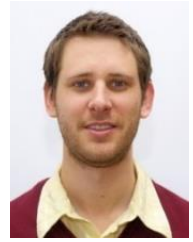
Thomas Metcalf Travel Award Summary

Solar Polarization Workshop 9

August 29 – 30, 2010 Göttingen, Germany



Francisco A. Iglesias studied electronics engineering at the National University of Technology (UTN-FRM) in Mendoza, Argentina. In 2016, he received his Dr.-Ing degree from TU Braunschweig and the Max Planck Institute for Solar System Research in Germany. He specializes in the development of optical spectropolarimeters for high-resolution, high-precision solar magnetometry, with an emphasis in high-cadence applications to mitigate instrumental and ambient spurious effects such as atmospheric seeing. He is currently an assistant professor at UTN-FRM and a postdoctoral fellow at the National Research Council in Argentina.

Invited review talk - Techniques in solar spectropolarimetry

Instrumentation for imaging solar polarimetry has continuously improved during the last five decades. Besides the complementary radio and high-energy regimes, the combination of optical spectropolarimetry and numeric Stokes inversion is the dominant technique currently used to probe the solar photosphere and chromosphere, particularly their driving magnetic fields. The ubiquitous but relatively small and weak fields in the quiet Sun are believed today to be crucial for answering many open questions in solar physics. However, detecting such fields require measurements with simultaneous high resolution and sensitivity. This is a challenging regime because of the trade-offs that appear due to the high dimensionality of the spectropolarimetric data, and the intrinsic signal-to-noise-ratio limitations when imaging rapidly evolving signals, among others. In this talk we review well-established and upcoming instruments, with an emphasis on those aiming for the above-mentioned regime. It is an exciting time to do so because we are at the verge of the 4-m ground observatories era and there have been important advances in related technologies. Above the atmosphere, space missions are venturing away of 1 AU, and rocket and balloon platforms are aiming to do imaging polarimetry in unexplored spectral ranges. All these are pushing spectropolarimeters towards qualitatively novel designs, some highlights are:

- CMOS imaging detectors have made great improvements in the last decade, pushing back CCDs in many upcoming instruments. However, CMOS calibration has proven difficult when very high sensitivity is aimed. Custom sensor designs, such as the one used in ZIMPOL, have proven useful. Novel approaches based on DePFET or polarization cameras are being considered for solar observations.
- Dual beam is still the most used polarization modulation technique, with crystal-based devices of spread use and recently space qualified. Dual-frequency liquid crystals are being developed to overcome aperture limitations. Few technologies for snapshot spectropolarimetry have been proven in astronomy and are being explored in solar physics with limited results. A full-Stokes spatial modulator, if available, could achieve this when combined with an integral field spectrometer.
- Even though spectrographs and filtergraphs are a mature technology, they have limitations, some of which are being tackled by the development of integral field solutions and of novel post-facto image restoration techniques. Moreover, an effort is being put on improving efficiency in the UV and IR regimes, and observing many spectral lines simultaneously with increased spatial resolution.

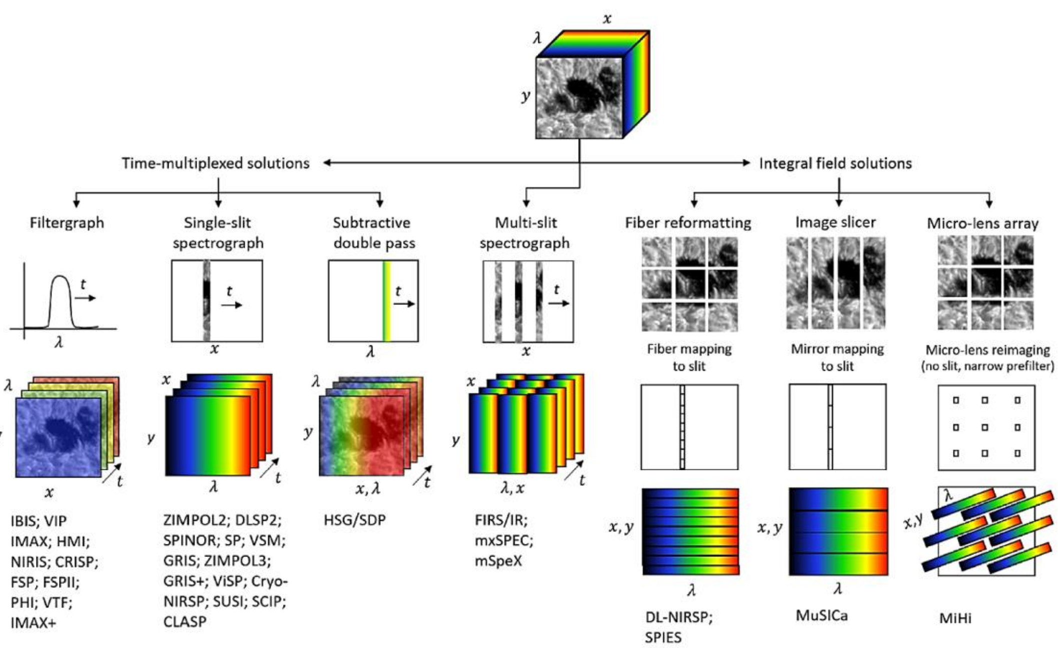


Figure: Seven different spectral mapping techniques used in solar spectropolarimetry. The cube (x, y, and λ) at the top can be mapped to the 2-D detector (bottom row) either by time-multiplexing, as done in the popular tunable filtergraphs and slit spectrographs, or by making use of a larger detector area to accommodate the individual spectra in a single frame exposure. The latter is used in the integral field solutions, which are mostly under development and can perform snapshot-spectroscopy at the expenses of a reduced FOV. The multi-slit spectrograph can be considered an in-between solution. We have listed example instruments using each technology at the bottom. Adapted from Iglesias F. A. and Feller A., Opt. Eng., 58(8), 082417 (2019)