Multi-Wavelength Far-Infrared Polarimetry with SOFIA

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Questions for SOFIA Far-IR Polarimetry

- What is the field strength of magnetic fields in molecular clouds, as inferred through the Chandrasekhar-Fermi (1953) method?
- What is the configuration of the magnetic field in the Galactic Center?
- What are the large grain populations in molecular clouds, and which are aligned?
- What is the configuration of the magnetic field in a statistical sample of YSOs?
- Is the far-IR polarization from other galaxies detectable, at a level appropriate for further study from space?

HAWCPol: A First Far-IR Polarimeter for SOFIA

At JPL, we are actively building HAWCPol, a multi-band polarimeter for the first-generation far-IR camera HAWC (Harper et al. 2004). It will be ready for integration with HAWC in Summer 2011 and will support all of the original camera modes in addition to adding new science capability.

HAWCPol detects polarization with a slowly rotating quartz half-wave plate and fixed wire grid polarizer, both located in the pupil wheel. Components of HAWCPol have been demonstrated in the lab at cryogenic temperature, and we are currently assembling the full system over Summer 2010. The basic observing mode for HAWCPol is rapid (~10 Hz) chopping of the SOFIA secondary mirror, slow polarization modulation (~1 Hz), and occasional nodding of the telescope (~0.03 Hz).

HAWCPol detects polarization 30× faster than the KAO polimeter, for a given target surface brightness, and has 3× as many beams.

HAWCPol fills a gap in angular scale between Planck (>300") and SMA/ALMA (<10") polarimetry.

HAWCPol has competitive polarization sensitivity far into the future.

Only HAWCPol cleanly separates emission from cold and warm dust grains.

HAWCPol Specifications

| Field of view | 24 arcmin (10x) |
| Polarization modulation technique | quartz half-wave plate, 15 rpm |
| Minimum flux density to achieve polarization | 0.2% in 5 hour integration |
| Minimum column density to achieve polarization | A<sub>ν</sub> = 1, 2, 5, 4 |
| Systematic error goal | δθ < 0.2°, δβ < 2° |

Enabling Technology for Future Far-IR Polarimetry

Some of the more challenging projects for SOFIA polarimetry – mapping of interstellar features with size approaching a degree, and detection of cirrus – will require the latest possible detector arrays along with advanced mapping techniques. While HAWCPol uses cold quartz waveplates effectively, alternate polarization modulation techniques such as the Variable Polarization Modulator (VPM) permit operation over a wider range of wavelengths and at room temperature.

Left: The VPM consists of a polarizing grid in front of and parallel to a movable mirror. By varying the grid-mirror separation, the phase that is introduced between two orthogonal linear polarizations can be changed resulting in a modulation of the polarization state of the incoming radiation (Chuss et al. 2006). Right: Preliminary results are shown for a single VPM. The VPM modulates a single linear Stokes parameter as the grid-mirror separation is varied.

Contact / References

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