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A report on the 15th summer workshop of the National Solar Observatory at Sacramento Peak, entitled, 'IR Tools for Solar Astrophysics : What's next?' held during Sept. 19–23, 1994

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The main agenda of the meeting was to review new results obtained from extended object IR observations and to explore the potential capabilities of large-aperture, low-scattered-light instrumentation.

Some of the advantages of observing at infrared wavelengths are : the sky is black; the λ^2 dependence of the Zeeman splitting in contrast to the λ dependence of the Doppler width makes infrared lines a preference over the optical lines to measure weak magnetic fields; since the Plancks law approaches the Rayleigh-Jeans law in the infrared, it is a better measure of the mean of the temperature inhomogeneities.

Infrared solar astronomy is in its infancy and is severely limited by the present day telescopes and instrumentation. The largest full-wavelength coverage IR telescope is the 150 cm MC Math-Pierce facility at the Kitt Peak. It suffers from a low diffraction limited angular resolution at long wavelengths and poor seeing at short wavelengths.

An upgrade to a 4 meter aperture combined with seeing improvements and rapid guiding techniques is being proposed. Reflecting coronagraphs which would allow full wavelength coverage, achromatism and hopefully larger apertures to enhance both angular resolution and photon gathering are being developed. The NSO Large Reflecting Coronagraph (LRC) concept results from these developments. Its low scattered light/low emissivity characteristics make this 2 to 4 meter aperture telescope very attractive for both day and night observations. It is expected that this telescope might prove to be the world's best IR nighttime telescope since the technical requirements for day and night observations largely coincide.

There is a lot of promise in the infrared way of studying the Sun. The appropriateness of LTE in the infrared greatly simplifies the modeling of stochastic structures of different characteristic sizes of which the solar chromosphere is believed to be made up of. Spectrographic observations of the Stokes I and V profiles with the

IR FeI 15648 Å and 15652 Å lines yield information about the magnetic field, filling factor, magnetic flux and continuum contrast of the magnetic elements. Magnetic fields and velocities in bright umbral structures have been determined from long time sequences of high resolution Stokes-I spectra obtained with the near infrared FeI 10265.2Å. This weak line is among the very few lines with large Zeeman splitting that are unblended in the sunspot umbra. It has à triplet-like Zeeman pattern similar to a $g_{eff} \approx 2.5$ line and is slightly enhanced in the cool umbra. Time series of polarimetric observations of active regions with 1.5648 and 1.5652 microns can give very accurate time variation of the magnetic field strength. With the help of the slit spectra taken simultaneously in left and right circular polarization of 3 Å of the solar spectrum centred at 10830 Å in an active region, magnetic field inside decaying flare kernals have been measured. Bipolar structures of sizes less than 1400 km have been delineated at the photosphere. In addition correlated line-of-sight velocity flow and magnetic fields have also been seen. Several issues related to the existence of waves, shocks, shear and other fine structures in the flows and magnetic fields are being studied using the IR diagnostics.

The proposed coronagraphy may serve the extra solar community as well. The solar system astronomers would like to search asteroid satellites, observe gas releases about possible evolved comet nuclei and study cometry comae.

Todate, the primary night-time application of stellar coronagraphy has been to study dust in the vicinity of young stars, e.g. the detection of a dust disc around the nearby star Beta Pic. According to a leading hypothesis, the Beta Pic dust disc is released by comets travelling on highly elliptical and nearly star-grazing orbits. A family of comets on plunge orbits has been coronagraphically detected about the Sun, providing a close connection between our star and others.

The use of a large-aperture ground based coronagraph for detecting orbiting space debris is proposed. In this application, the coronagraphy would offer an additional advantage by observing in the near infrared where the background sky brightness is reduced. Calculations show that for an aperture of 2m, debris of 0.1 cm diameter in low earth orbit will be detected on short exposures acquired with IR array detectors. This is more than an order of magnitude smaller than the limiting debris size that can be detected by conventional telescopes of similar aperture.

Gravitational lensing is an important tool for the investigation of the deep universe. Distant sources lensed by compact and or extended distributions of intervening visible and dark matter give a wealth of cosmological information. But most of the observations of the faint lensed sources suffer from the blooming of the bright objects in the field, often associated with the gravitational deflector itself. The new generation of wide field coronagraphs can alleviate some of these problems.

In conclusion, coronagraphic techniques have proven useful for detection and photometric or spectroscopic observations of a faint object in the presence of a much brighter body and of faint extended structures about bright central objects.

The necessity for a coronagraph and low emissivity astronomical reflector has been felt both by the day time as well as the night time observers and this in itself may be sufficient to clinch the issue.

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