ABSTRACTS

4.07

The RISE Precision Solar Photometric Telescope Project

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The Radiative Inputs from the Sun to the Earth (RISE) program committee has identified the need for spatially resolved precision solar photometry as a key input to understanding the solar irradiance and luminosity changes. The RISE/PSPT project is a community-based program being undertaken by the National Solar Observatory to support this need. The basic plan calls for deploying photometric telescopes at two widely separated sites. Unlike GONG, the principle goal is not to obtain an unbroken time series but to escape local weather patterns that would hinder attempts to obtain approximately daily photometric data. The two-site network will allow occasional campaigns of faster cadence high precision photometry. The spatial resolution of the instruments will be matched to the 2K x 2K pixel format of the proposed detectors, and each instrument will measure surface brightness in different continuum and line wavelengths between CaK and Hα. Special emphasis is being placed on achieving differential photometric precision approaching 0.1% per pixel in continuum wavelengths with the PSPT instruments.

4.08

Fractal distributions of the intensity and velocity variations of the solar granulation

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The purpose of our investigation is to analyze the velocity and intensity field of the granulation layers by means of fractal statistics, based on Mandelbrot’s fractal geometry. In previous investigations we found that the distributions of intensity and velocity are non-Gaussian (most likely log-normal) and intermittent. On the other hand, the geometries of fractal distributions are characterized by their intermittent or “spoity” nature; they do not fill space. This characteristic is quantified by a parameter D, called the fractal dimension, which is to be contrasted with the dimension d of a Euclidean space. The statistics of random fractal fields depends strongly on the value of D compared to d, where the co-dimension d-D is a measure of the intermittency of the distribution. In fractal statistics, this co-dimension is expressed by the Hurst number H=d-D and characterizes distributions as persistent (H>0.5) or non-persistent (H<0.5). In the case of persistence, high amplitude of a property tends to be followed by high amplitude, and low amplitude followed by low amplitude. Distributions which are purely Gaussian show H=0.5.

Our observational material consists of spectrograms of high spatial resolution taken with the VTT at Izaña/Tenerife. We used the standard R/S (rescaled range) analysis to determine the Hurst number H, which defines the persistent or non-persistent character of the distribution with respect to the Gaussian (H=0.5). We found a clear difference between the velocity and intensity distributions, the former being persistent, the latter non-persistent. The fractal dimension of the intensity is D=1.3, and of the velocity D=1.7. Since the latter dimension is of order 5/3 it may be indicative of turbulence. Thus, the difference between intensity and velocity variations is also reflected by the fractal dimensions.

4.09

Vorticity and Divergence in the Solar Granulation

Y. Wang and R.W. Noyes (Harvard-Smithsonian CfA)

We have studied an outstanding sequence of continuum images of the solar granulation from Pic du Midi Observatory. Small bright points in the granulation pattern sometimes show very large vorticity—in one case with rotation speed as high as 3 km/sec, and angular velocity of 0.4 radian/min. We have calculated the horizontal vector flow field between successive pairs of images using a correlation tracking algorithm, and from this determined three scalar fields: the vertical component of the curl, the divergence, and the horizontal flowspeed. The divergence field has substantially longer coherence time than does the curl field. The curl of the flow field is largest at places with large negative divergence—that is, in areas of converging flow; this we associate with vortex motion accompanying downflows at granular, mesogranular, or supergranular boundaries. The average value of the divergence is largest (i.e. largest outflow) where the horizontal flowspeed is large; we associate these regions with exploding granules.

4.10

Progress in Automatic Recognition of Solar Features

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Although humans can easily recognize solar features in most images, it is not always easy to teach a computer to recognize these features. Substantial progress is being made, however, in developing computer algorithms that can automatically recognize sunspots, filaments, and large-scale magnetic field patterns.

Automatic adaptive thresholding has been tested for recognizing sunspots observed in white light. This process selects and applies an intensity threshold that represents the level of greatest boundary contrast within an image. Although this technique works well near disk center, it does not work well for images with strong intensity gradients. Either these gradients should first be removed or a region-growing technique should be tried. (Dark portions of the image would be drawn outward to include all neighboring points satisfying various similarity criteria.)

A valley-detection algorithm is being tried for recognizing solar filaments observed in Hx. All pixels representing local valleys in the low-pass filtered image are identified and linked to form chains of valley points. The confidence that these chains represent filaments is then derived from properties such as intensity, contrast, width, length, and linearity of the chain. The next analysis step will require a grouping algorithm, which will combine filament pieces into a single filament.

A variation of a gray-scale morphological operation is being developed to extract large-scale magnetic field patterns from solar magnetograms. This is done by summing the original image with local minimum and maximum images (derived from extrema in each local neighborhood) and then applying low-pass filters to remove small-scale structures. The next step will use the gradients in this image to develop a measure of the confidence in the location of the derived large-scale magnetic neutral line.

4.11

A HOLOGRAPHIC NARROW-BAND FILTER FOR SOLAR OBSERVING

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and

Harold Zirin, Caltech

We describe a narrow-band filter for Hx developed by Accuwave Corporation, and currently in use at BBSO. The filter has FWHM of 0.125 Å and effective transmission of 10%. Side band suppression is down by -40 dB 0.11 Å from the peak, and the general suppression is orders of magnitude better than a Lyot filter.