23.08

MULTI-VARIATE SPECTRAL ANALYSIS OF SOLAR IRRADIANCE VARIATIONS

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A multi-variate spectral analysis is used to study the influence of sunspots and bright magnetic elements on the solar total and UV irradiances during solar minimum and the rising portion of solar cycle 22. It is shown that most of the power in the spectrum of the SM/AGSM total irradiance variance is explained by sunspots. During solar minimum, when only a few sunspots occurred, the bright magnetic elements caused most of the total irradiance variations around the 27-day rotational period. We have also found that, besides plages, the magnetic fields of sunspots also modify the UV irradiance at Lyman alpha. After eliminating the effect of sunspots and bright magnetic elements from the power spectra of total and UV irradiances, there are still peaks around 27, 14, and 9 days. This indicates that additional solar events, e.g. large-scale motions, influence both total and UV irradiances.

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23.09

MODELLING SOLAR UV IRRADIANCE

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Variation in solar UV irradiance at Lyman alpha is studied on short time scales (from days to months) after removing the long-term changes over the solar cycle. The SME/Lyman alpha irradiance is estimated from various solar indices (such as total irradiance corrected for sunspot darkening, Ca-K plage index, full disk equivalent width of the He line at 1083 nm, 10.7 cm radio flux, sunspot blocking function, and Fe XIV coronal green line index at 530.3 nm) using linear regression analysis. In order to study the non-linear effects, the Lyman alpha irradiance is modelled with a 5th-degree polynomial as well. The full disk equivalent width of the He line at 1083 nm is found to offer the best proxy for Lyman alpha. It is shown that approximately 72% of the solar-activity-related changes in Lyman alpha irradiance arise from plages and the network. The network contribution is estimated to be about 19%. It is also shown that significant variability remains in Lyman alpha irradiance around periods at 300, 27 and 13.5 days, which is not explained by the solar indices. Since the non-linear effects account for only a small part of the unexplained variation in Lyman alpha irradiance, additional events, e.g. large-scale motions, may explain the discrepancies found between the observed and estimated irradiance values.

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23.10

Measurements of Facular Contrast in the Near Ultraviolet

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Measurements of facular contrast across the solar spectrum are required to determine the facular contribution to solar irradiance variation. Until now there have been no measurements in the near ultraviolet except near the limb (λ < 0.4μm). We have measured the contrast of active region and network faculae across the disk at 3300 Å and 3650 Å, on photographic images of the solar disc obtained at the Mt. Wilson Observatory. We find that facular contrast at each wavelength increases from approximately 2% at disk center to 12% at the limb, when measured with roughly 1.5″ spatial resolution. Given that about 10% of the total irradiance lies at λ < 4000Å, these relatively high contrast values in the near-UV across the disc account for about 20% of the facular contribution to variation of the total solar irradiance.

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23.11

Precision Visible and Infrared Solar Photometry

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In this paper we report the development of an instrument designed to measure the large scale thermal structure of the solar photosphere. The instrument does broad band, medium resolution full disk imaging at 500 nm and 650 nm with a CCD system. With a new IR array detector the measurement was extended to the near infrared (1.2-2.2 microns). The scattered light in the system was carefully minimized. Using a new flat-fielding technique, we achieved better than 10⁻² per pixel accuracy.

23.12

The Solar Stellar Irradiance Comparison Experiment

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The solar UV irradiance measurements from the Solar Mesospheric Explorer (SME) indicate that solar cycle variability is far smaller than previous estimates. Although the Sun varies by nearly a factor of two at Lyman α (121.6 nm), at wavelengths from 120 to 170 nm the Sun varies by less than 20%. From 180 to 300 nm the variability quickly decreases to less than 1%. The challenge for future observations is to make spectral measurements with a long term accuracy far better than 1%. One approach is to directly compare the solar irradiance to the UV output of a number of bright early-type stars. The first comparison of this type will be made with the Solar Stellar Irradiance Comparison Experiment (SOLSTICE). SOLSTICE I is scheduled to be flown on the Upper Atmosphere Research Satellite (UARS) in the fall of 1991, and SOLSTICE II is planned for a launch in the late 1990s as part of the Earth Observing System (EOS). The ratio between the solar and stellar UV fluxes is about 6 orders of magnitude. To achieve this degree of sensitivity change while retaining the same optical components for the solar and stellar observations, SOLSTICE employs different entrance slits (x 10⁴ in area), exit slits (x 10⁶ in width), and integration time (x 10³ in time).