The UV "Sun as a Star" Flare Spectrum Observed with SOLSTICE

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1. Introduction

The SOLSTICE instrument gives us an unique possibility to observe the Sun "as a flare star" and to relate the observations with results from stellar UV instruments. Using the enhancement in the ultraviolet (UV) emission reported in previous solar flare observations and placing the Sun at a typical flare star distance (5-50 pc), its flares would not be detectable from Earth. However, the present observation from SOLSTICE indicates that the increase in UV flux during some very large solar flares is comparable to recent stellar flare observations (e.g., Robinson and Carpenter 1995) Therefore, we must consider the possibility that the Sun may sometimes display "flare star" characteristics.

2. Observations and results

An observation of the ultraviolet spectrum (1200 to 1800 Å) during the impulsive phase of a very extended 3B-X3 class solar flare on 27 February 1992 has been obtained with the Solar-Stellar Irradiance Comparison Experiment – SOLSTICE (Rottman et al. 1993). This flare shows a dramatic enhancement of lines formed in the solar transition region. The full disk irradiance (i.e. the Sun as a star) of the resonance lines of C IV and Si IV increased by a factor of 15-20 during the impulsive phase of the flare which is comparable to flux enhancement during stellar flares.

The observation is compared with ground based H\(\alpha\), magnetogram, and microwave observations as well as hard X-ray measurements from the Ulysses spacecraft. By taking into account the emitting area the radiance of the flare increased by a factor of 20,000 or more relative to the non-flaring background. Such enhancement far exceeds previous published values (e.g. OSO 8, Skylab, and SMM) where transition region lines increased about a factor of 100. These results were probably affected by limited dynamical range and temporal resolution. Thus, our SOLSTICE observation may be the first measurement of the UV enhancement during large flares (Brekke et al. 1996).

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Figure 1. The SOLSTICE spectrum recorded during the impulsive phase of the February 27 1995 flare compared to a "normal" spectrum recorded the previous day.

In addition to C IV and Si IV, the the Si III multiplet near 1295 Å also shows remarkable enhancement. Most other allowed lines such as C II, Si III(1206 Å), N V, and He II show moderate enhancements. The weakest enhancement of all is the H I Lyman-α, for which the irradiance increases only 10%. Some of the differences between the various enhancements are probably due to the observations timing since the scanning spectrometer observes different spectral features with up to 4 minutes time difference. During the flare the strong transition region lines are systematically redshifted by 50 km s⁻¹.

At present SOLSTICE is the only UV instrument that could observe such large flux enhancements as presented in this paper. Also, SOLSTICE gives us an unique possibility to observe "the Sun as a star" and to relate the observations with results from stellar UV instruments. Thus, we plan to operate SOLSTICE in a "flare-mode" to obtain both spectra and light curves at discrete wavelengths. TRACE, to be launched in 1997, is another instrument with sufficient dynamic range to study flares.

References

Robinson, R. D., and Carpenter, K. G. 1995, This volume