

## MEASURING THE IONIZATION RATE OF IN-FLOWING INTERSTELLAR HELIUM WITH THE SOHO/CELIAS/SEM

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### Abstract

The absolute measurement of solar EUV flux and its time dependence provide critical data on the solar driven photochemistry which results in solar system objects. In addition, the SEM measurements also provide the data required to determine the absolute photoionization rate of neutral interstellar helium flowing into our solar system. After hydrogen, helium is the most abundant substance found in interplanetary space, and the interstellar medium. In the inner solar system photoionization of helium is the dominant ionization process of the inflowing interstellar neutral helium. Thus, an accurate determination of the solar photoionization rate is a requirement in astrophysical research. The daily averaged photoionization rate of helium at 1 AU, derived from the SOHO CELIAS/SEM absolute solar extreme ultraviolet (EUV) flux values is presented for the time period since the launch of SOHO in December, 1995.

### Instrument: Solar EUV Monitor (SEM)

The Solar EUV Monitor (SEM) instrument is a highly stable EUV transmission grating spectrometer (Hovestadt et al., 1995, Judge et al., 1998). It consists of a high-density transmission grating (5000 bars/mm) with an aluminum filter directly in front of it to limit the radiation band pass of the spectrometer. The dispersed radiation is detected by three highly efficient, aluminum coated silicon photodiodes positioned 200 mm behind the grating at the zero-order and the 30.4 nm first order positions. The zero-order detector is primarily sensitive to radiation between 0.1 and 50.0 nm. The first order detectors monitor the full disk solar irradiance within an 8 nm bandpass centered at 30.4 nm. In both cases (zero and first-order), the detector output is an integral flux measurement of the radiation within the detectors bandpass.

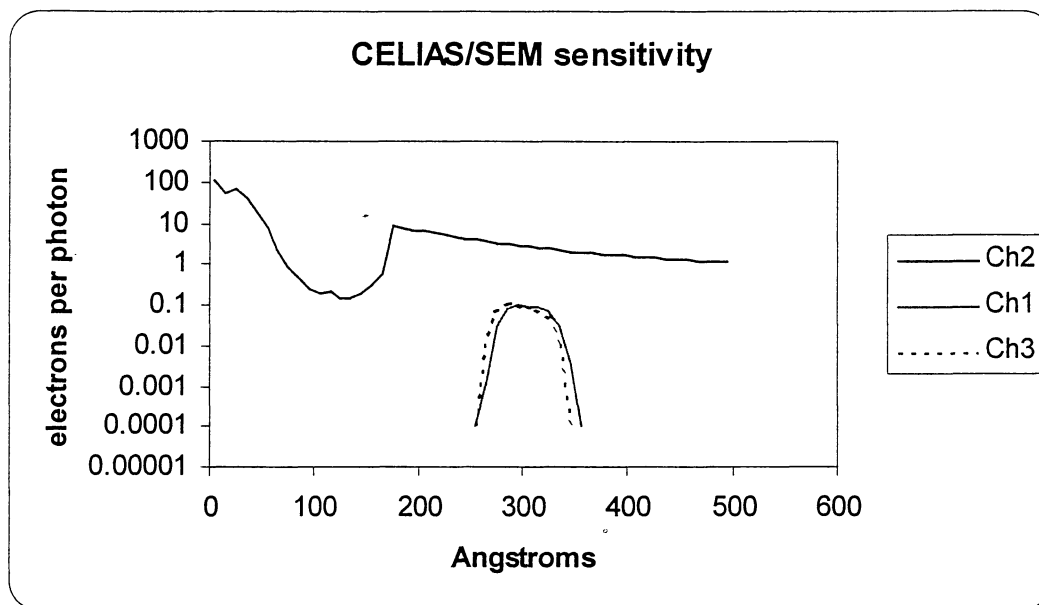


Figure 1. The bandpass and sensitivity for the CELIAS/SEM on SOHO.

### Determining the photoionization rate

Photoionization rates are calculated by folding the measured solar EUV irradiances into theoretical or laboratory measured photoionization cross sections [See Banks and Kockarts [1973], Torr et al. [1979], Torr and Torr [1985]. The defining rate equation is applicable for an optically thin medium, and is given by

$$\nu_0 = \int \Phi(\lambda) \sigma(\lambda) d\lambda \quad (1)$$

In Equation (1),  $\nu_0$  is the photoionization rate of helium in  $s^{-1}$ ,  $\Phi(\lambda)$  is the solar flux at wavelength,  $\lambda$ , in photons  $cm^{-2} s^{-1}$ , and  $\sigma(\lambda)$  is the photoionization cross section in  $cm^2$ , as a function of wavelength,  $\lambda$ . The wavelength distribution of the integrated irradiance measured by the SEM is determined by using the SOLARS22 relative solar spectrum [see Woods, et al., 1998] The absolute helium photoionization cross-sections over the spectral region of interest are from Samson, et al. [1994].

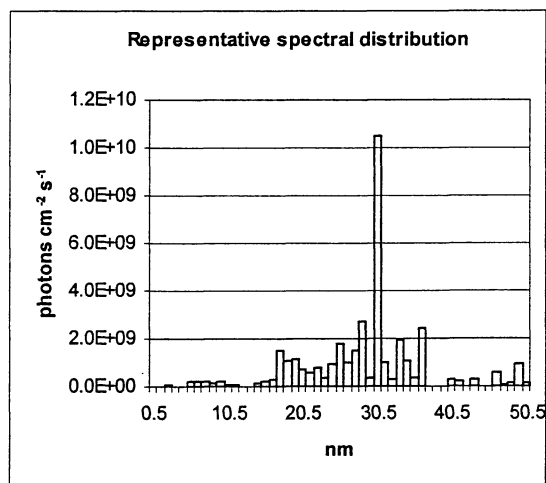


Figure 2a. The spectral distribution (Woods et al., 1998) used to determine the effective contribution to the total photoionization rate for each 1 nm wavelength bin from the SEM solar irradiance measurements.

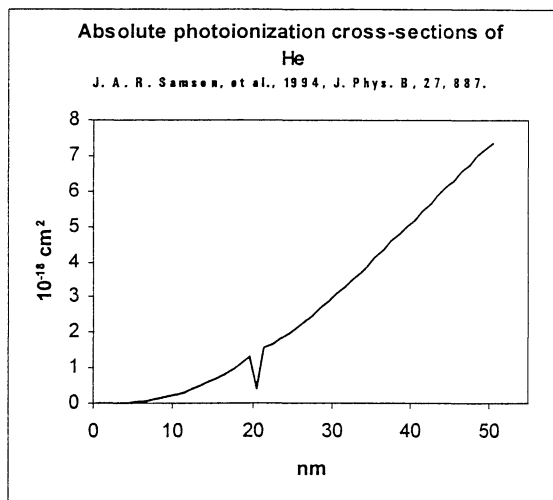


Figure 2b. The photoionization cross sections (Samson et al, 1994) combined with the relative spectral distribution from Figure 2a above to produce the effective contribution to the total photoionization rate for each 1 nm wavelength bin.

### Results

Using calibrated irradiance values from the CELIAS/SEM instrument, the photoionization rate of helium has been determined throughout the solar cycle observed to date by SOHO. Daily values for the ionization rate at 1 AU are derived from the daily average flux values and are plotted below. The ionization rates up to every 15 seconds are also available upon request.

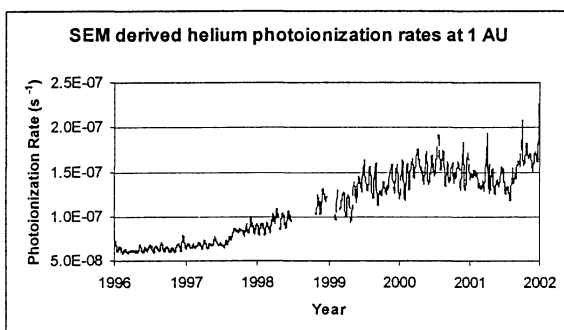


Figure 3. The daily averaged photoionization rate of helium derived from SEM irradiance measurements at 1 AU.

### References

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