



Stellar Observations with the UARS SOLSTICE



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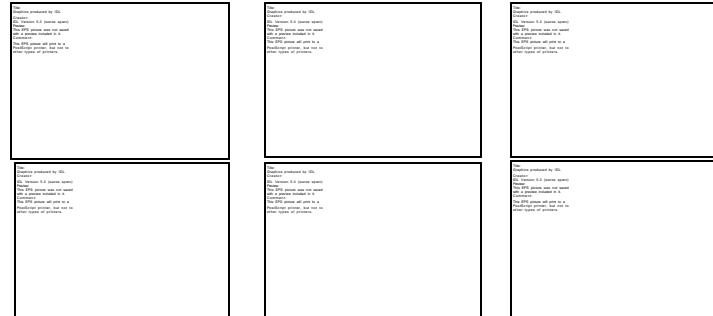
Individual Stellar Observations of an Ensemble of Stars

Typical stellar experiments last 200-600 seconds. The observed count rate is recorded every 1024 ms and then later converted to physical units.

After correction for dark rate, filtering for SAA or any other anomalies, the best estimate of flux is determined by a Gaussian fit. The uncertainty in the value of the peak is the 1-sigma width of the distribution divided by the square root of the number of samples.

Exposure times are determined by the count rate. The selected exposure time produces about 10⁴ total counts so that counting statistics produce only about 1% uncertainty in the flux. For example, a count rate of order 100 sampled 200 times yields a fractional uncertainty of less than 1%.

$$s \approx \frac{1}{\sqrt{C} \sqrt{N}} \approx \frac{1}{\sqrt{100} \times 200} = 0.7\%$$



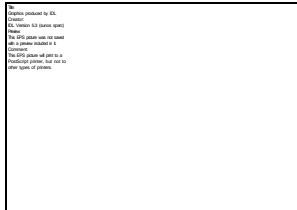
SOLSTICE observes stars at 18 standard grating positions that span the wavelength range of each channel. Thus the degradation is measured at 36 different wavelengths over the range 118-315 nm (G and F channels), about every 4 nm in the G channel and about every 8 nm in the F channel.

The SOLSTICE instrument observes an ensemble of stars on a regular basis to track the degradation in sensitivity. We have chosen bright, early-type stars that are expected to be stable over a timescale of centuries. Each such star could act as a "standard candle" on its own, but we avoid the possibility of a pathological case by using many stars. The time series of the individual stellar measurements are used to derive the instrument degradation function.

Fluxes are in units of 10⁴ photons/m²/s/nm

One-Day Hits

The UARS SOLSTICE instrument has experienced a number of instantaneous losses to sensitivity. These can be traced to spacecraft operator errors (solar observation with stellar slits in place, wrong day's command load executed, etc.) and have a significant effect on the total sensitivity loss over the lifetime of the instrument.



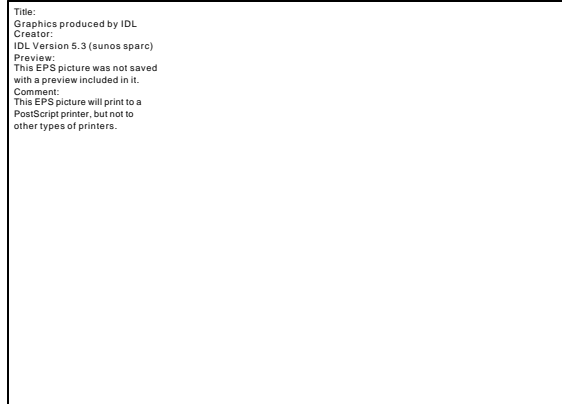
Observations of the ensemble of stars are combined to produce a single model of the instrumental degradation function.

A least-squares fit determines relative normalization between all the stars as well as spline fit (cf. panel on right).

One-day hits have also been removed.

The UARS tape recorder (Oct 1999) and star tracker (Aug 2000) have both failed, so stellar observations are no longer available after Aug 2000. An exponential fit to the data from 1995-2000 is used to extrapolate the degradation curve to the present.

Degradation Function



This plot shows the normalized fluxes for the stars used at this wavelength.

The number in parentheses in the legend box is the relative brightness of each star as determined by the fit.

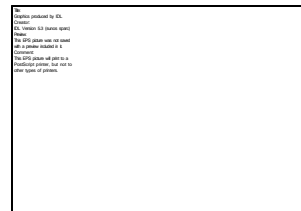
Exposure Time: The UARS SOLSTICE instrument is occasionally powered off. During such periods, no observations are taken, and long-term degradation is negligible. We removed these time periods when calculating the degradation function.

Least-Squares Fitting

The degradation function is determined by a least-squares fit to the data. The observed fluxes are corrected for one-day hits, and then fit with a combination of exponential and spline functions. The free parameters in our fit are the normalizations of the individual stars (i.e., their relative brightness) and the coefficients of the functions. Since we assume that the correction factor at the start of the mission is 1.0, we use an exponential fit up until the time of the first one-day hit. The slope of the degradation curve changed at that point, so we use a spline function from that point onwards. Finally, we fit an exponential curve to the last few years of available stellar data and use that to extrapolate the curve. A single spline function is then fit to the real and extrapolated data to calculate the degradation correction at any given time.

The fitting software makes use of Craig Markwardt's IDL implementation of the MINPACK-1 non-linear least-squares package (<http://astro.nyu.edu/~wtsc/edu/craig/markwardt/idl.html>) as well as a large number of IDL and FORTRAN routines developed at LASP.

Solar Irradiance

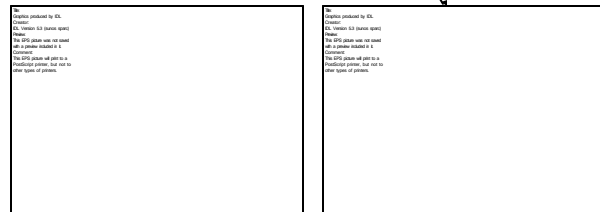


The primary job for the degradation curve derived from the stellar observations is to correct the solar observations.

The shaded portion of the curve uses the extrapolated degradation curve.



Stellar Irradiance



The ensemble degradation curve can also be used to correct the stellar fluxes, producing an absolutely calibrated stellar spectrum. Unlike IUE (and HST), SOLSTICE derives its calibration from ground-based standard sources. The uncertainty in the absolute calibration is estimated to be about 5%.

The plot on the left shows the SOLSTICE observations of eta UMa at 153.5 nm after correction by the derived degradation curve. A 1% error bar is shown for comparison.

The plot on the right shows how the SOLSTICE spectrum of eta UMa compares to published catalogs. The IAO-2 and TD-1 fluxes have been corrected to the IUE common scale (cf. Bohlin & Holm 1984). The IUE fluxes are from the HST Calibration Database.

