To: Distribution
From: M. Zombeck
Subject: Model of HRC-S (thinnest inner segment;) response to out of band radiation
Predicted HRC-S QE based upon the following model parameters:

HRC-S UVIS (SN 002) inner segment (S/N 12):

Polyimide: 2750 +/- 142 A
Al: 307 +/-30 A

$t_{poly} := 2750 \cdot 10^{-8}$ cm

$t_{Al} := 307 \cdot 10^{-8}$ cm

These thicknesses are based on Luxel's measurement of the Al thickness and our determination (via x-ray measurements) of the polyimide thickness. No witness samples are available. The out-of-band transmission model for the UVIS is based upon:

Derived attenuation coefficients from our measurements for polyimide at Berkeley in the UV ; Hagemann, et al. for Al attenuation coefficients in the UV. Near UV and visible transmission measurements of witness sample TF100-565 (polyimide is thinner than this segment).

A slab model is used below 3200 A. The measured transmission of a similar witness sample is used above 3200 A.

The MCP QE is based upon the model in "Instrument Performance Model", M. Zombeck, 1995.

$$qe := \begin{bmatrix} 114 & .60 \\ 160 & .51 \\ 256 & .13 \\ 304 & .185 \\ 470 & .23 \\ 584 & .275 \\ 834 & .24 \\ 1024 & .24 \\ 1216 & .20 \\ 1400 & .20 \\ 1500 & .22 \\ 1600 & .20 \\ 1700 & .10 \\ 1800 & .06 \\ 1900 & .04 \\ 2000 & .01 \\ 2200 & .0001 \\ 2537 & 4 \cdot 10^{-7} \\ 5500 & 4.5 \cdot 10^{-11} \end{bmatrix}$$

The efficiency of CsI over the wavelength range 10 - 5500 A.

Sources:

10 - 2200 A, Barstow (1986), Martin & Bowyer (1982), Fraser, et al. (1982); 2537 A, Borovick-Romanov and Peskov (1994); 5500 A, best estimate, this report.

The linear attenuation coefficients for polyimide and Al are given by

$$\mu := \begin{bmatrix} 100 & 2.5\cdot10^{4} & 3.6\cdot10^{5} \\ 200 & 9.9\cdot10^{4} & 2.7\cdot10^{4} \\ 304 & 3.1\cdot10^{5} & 3.5\cdot10^{4} \\ 470 & 4\cdot10^{5} & 4.3\cdot10^{4} \\ 584 & 5\cdot10^{5} & 5.4\cdot10^{4} \\ 834 & 4\cdot10^{5} & 8.5\cdot10^{4} \\ 1024 & 3.75\cdot10^{5} & 5\cdot10^{5} \\ 1216 & 3.5\cdot10^{5} & 1.1\cdot10^{6} \\ 1400 & 2.6\cdot10^{5} & 1.25\cdot10^{6} \\ 1500 & 2.6\cdot10^{5} & 1.3\cdot10^{6} \\ 1600 & 2.7\cdot10^{5} & 1.3\cdot10^{6} \\ 1700 & 2.8\cdot10^{5} & 1.35\cdot10^{6} \\ 1800 & 3.4\cdot10^{5} & 1.37\cdot10^{6} \\ 1900 & 3.5\cdot10^{5} & 1.38\cdot10^{6} \\ 2000 & 3.3\cdot10^{5} & 1.39\cdot10^{6} \\ 2200 & 3.0\cdot10^{5} & 1.42\cdot10^{6} \\ 2537 & 3.10\cdot10^{5} & 1.45\cdot10^{6} \\ 3000 & 2.5\cdot10^{5} & 1.48\cdot10^{6} \\ 4000 & 1.3\cdot10^{4} & 1.49\cdot10^{6} \end{bmatrix}$$

We will make a linear interpolation to define the QE everywhere over the band 100-2

$i := 1 .. 18$

Wavelength vector: $vx_i := qe_{i,1}$

QE vector: $vy_i := qe_{i,2}$

The interpolating function:

$$QElin(\lambda) := linterp(vx, vy, \lambda)$$

Fit the band 2000-2537 with an exponential function:

$$QEexp(\lambda, a, b) := a \cdot \exp(-b \cdot \lambda)$$

$i := 16 .. 18$ $\quad SSE(a,b) := \sum_i \left(qe_{i,2} - QEexp\left(qe_{i,1}, a, b\right)\right)^2$

$a := 2.73 \cdot 10^{14}$ $\quad b := 0.02$

Given

$SSE(a,b) = 0$ $\quad 1 = 1$

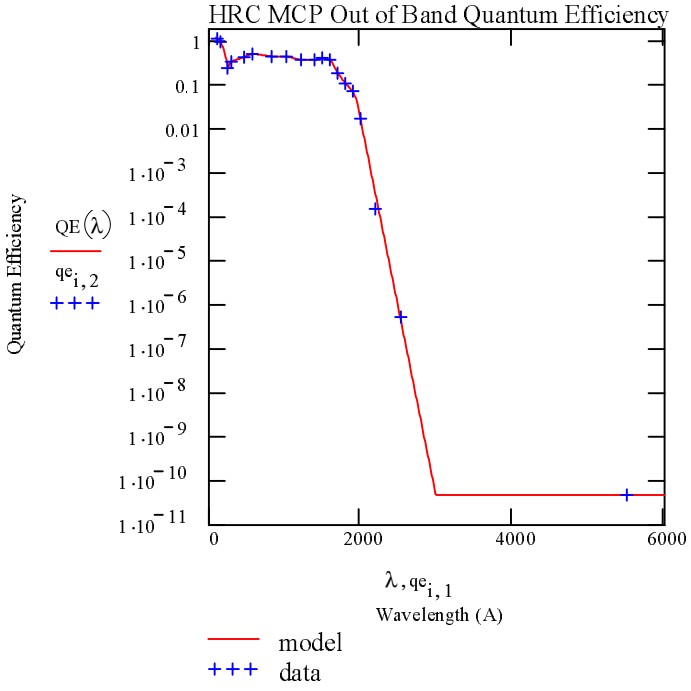
$\begin{bmatrix} a \\ b \end{bmatrix} := Minerr(a,b)$ $\quad a = 6.676 \cdot 10^{14}$ $\quad b = 0.019$

Fit the band 2537-2995 with the same exponential function and fit the band 3000-6000 A with a constant equal to the QE at 5500 A.

Construct a piecewise continuous function:

$$QE(\lambda) := if\left(\lambda \le 2000, QElin(\lambda), if\left(\lambda \le 2995, QEexp(\lambda, a, b), qe_{19,2}\right)\right)$$

A plot of QE: $i := 1 .. 19$ $\quad \lambda := 100, 110 .. 6000$



We will make a linear interpolation to define μ for polyimide everywhere over the band.

$i := 1 .. 18$

Wavelength vector:

$vx_i := \mu_{i,1}$

QE vector:

$vy_i := \mu_{i,2}$

The interpolating function:

$\mu_{polylin}(\lambda) := linterp(vx, vy, \lambda)$

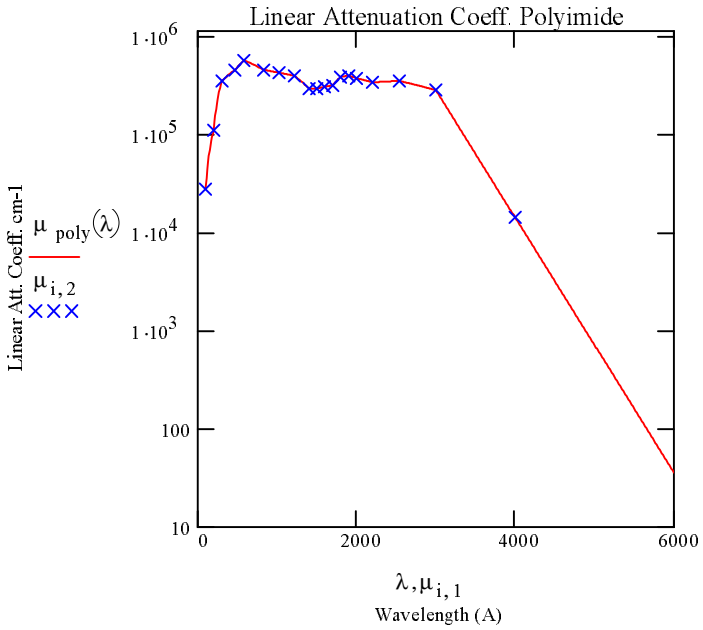
Fit the band 3000-6000A with an exponential.

$\mu_{polyexp}(\lambda) := 1.778 \cdot 10^{9} \cdot \exp\left(-2.957 \cdot 10^{-3} \cdot \lambda\right)$

$\mu_{poly}(\lambda) := if\left(\lambda \le 3000, \mu_{polylin}(\lambda), \mu_{polyexp}(\lambda)\right)$

A plot of μ:

$\lambda := 100, 110 .. 6000$ $i := 1 .. 19$



We will make a linear interpolation to define μ for aluminum everywhere over the band.

$i := 1 .. 19$

Wavelength vector:

$vx_i := \mu_{i,1}$

QE vector:

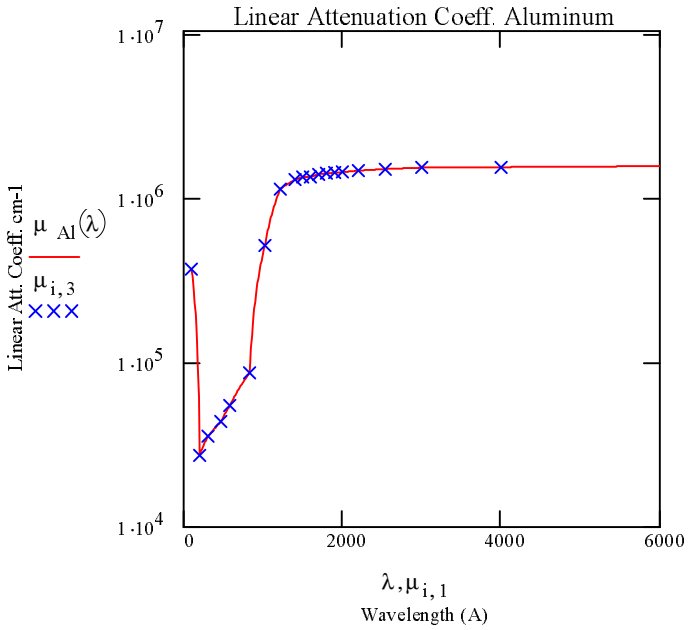
$vy_i := \mu_{i,3}$

The interpolating function:

$\mu_{Al}(\lambda) := \text{linterp}(vx, vy, \lambda)$

A plot of μ:

$\lambda := 100, 110 .. 6000$



In order to model the transmission in the visible and near UV we will use witness sample file: S565.prn. This will overestimate the transmission.

Sample description: TF100-565, R/N 0667-8, 315A Al:Si 2040A Polyimide

Read in the spectrophotometer scan data:

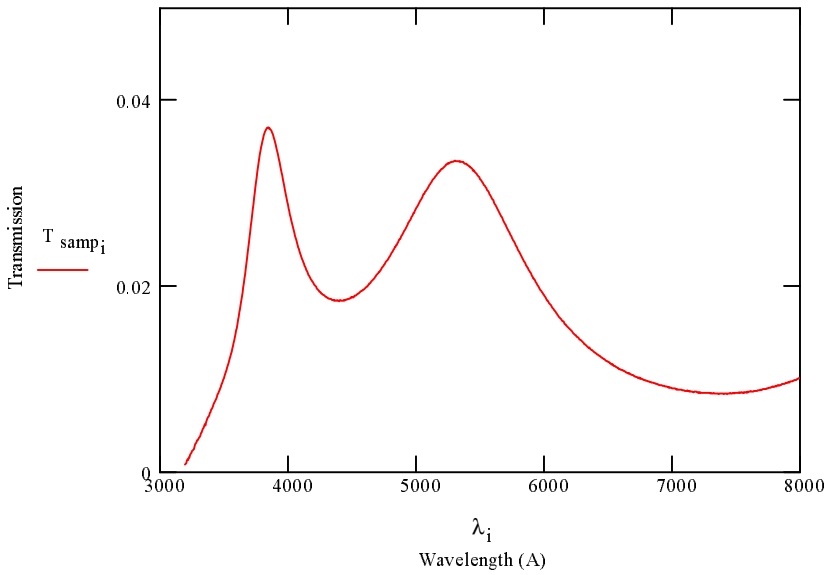
$scandata := READPRN("tf565.prn")$ Define variables:

$\lambda := scandata^{<1>}$ wavelength vector (unit is Angstroms)

$T_{samp} := scandata^{<2>}$ transmission vector

Set negative transmissions to 0.0:

$i := 241 .. 1201$ $\quad T\,samp_i := if(T\,samp_i < 0, 0.0, T\,samp_i)$



We will make a linear interpolation to define T for the sample everywhere over the band.

$i := 1 .. 1201$

Wavelength vector: $vx_i := \lambda_i$

Transmission vector: $vy_i := T\,samp_i$

The interpolating function:

$T_{wit}(\lambda) := linterp(vx, vy, \lambda)$

Calculate visible light transmission:

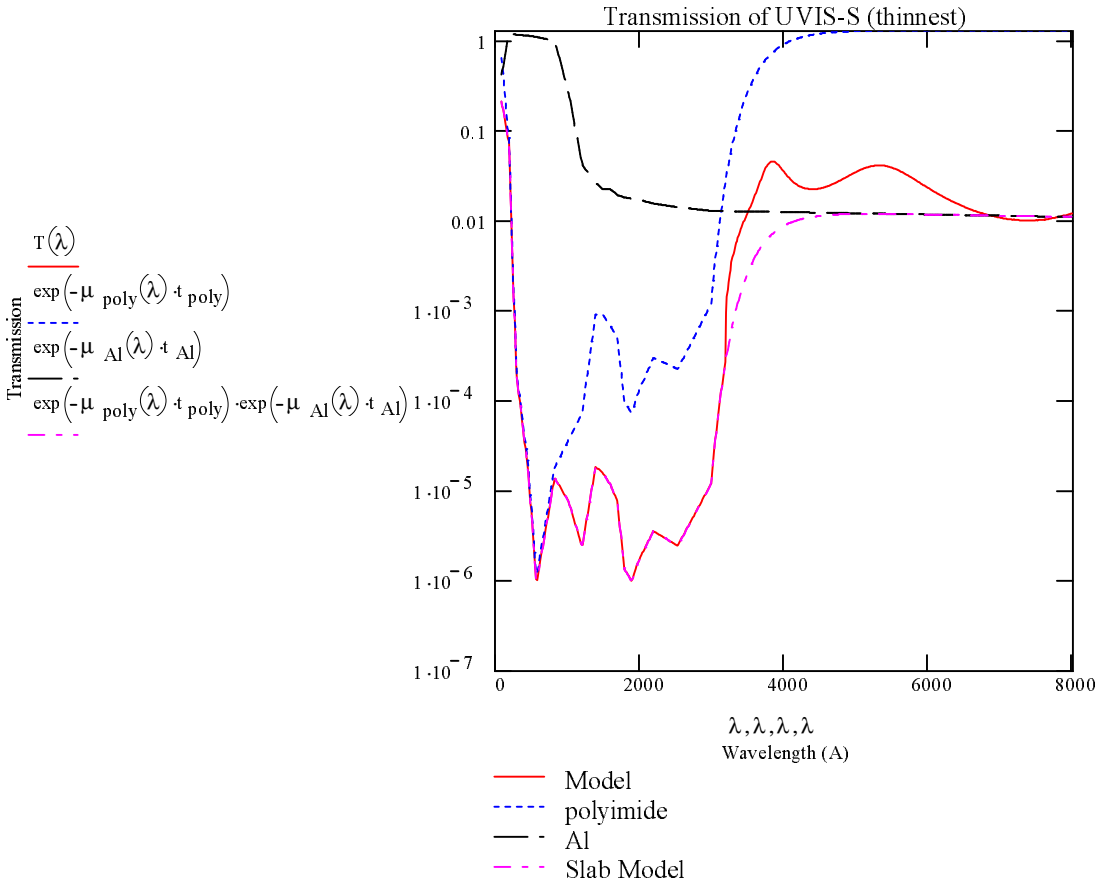
$$T_{vis} := \frac{\int_{4000}^{7000} T_{wit}(\lambda)\,d\lambda}{(7000 - 4000)} \qquad T_{vis} = 0.021$$

We will calculate the transmission of the UVIS:

$$T(\lambda) := \text{if}\left(\lambda \le 3200, \exp\left(-\mu_{poly}(\lambda)\cdot t_{poly}\right)\cdot\exp\left(-\mu_{Al}(\lambda)\cdot t_{Al}\right), T_{wit}(\lambda)\right)$$

A plot of T:

$$\lambda := 100, 110 .. 8000 \qquad i := 1 .. 11$$

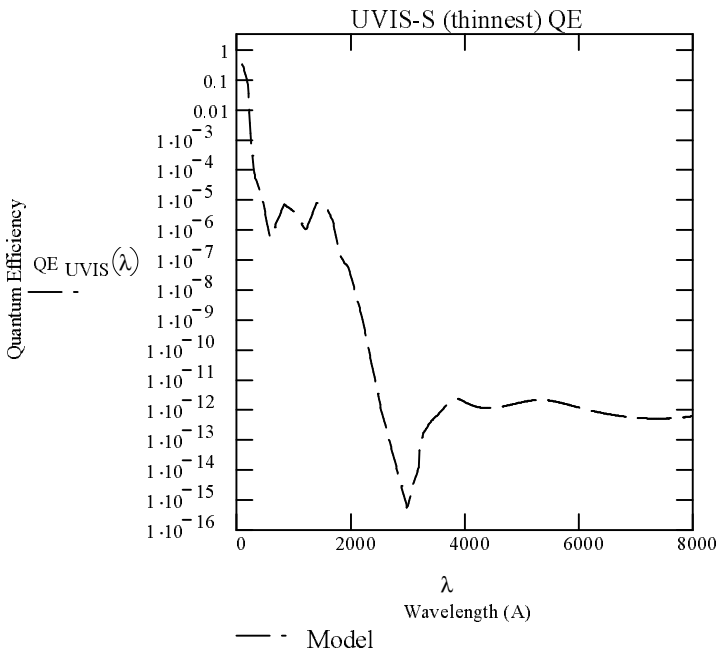


The qe of HRC-S for the thinnest segment is then:

$QE_{UVIS}(\lambda) := T(\lambda) \cdot QE(\lambda)$

A plot of QE_{UVIS}:

$\lambda := 100, 110 .. 8000 \qquad i := 1 .. 2 \qquad L := 100, 110 .. 3000$



Define wavelength and transmission vector and transmission matrix:

$i := 1 .. 791$

$lambda_i := 100 + (i - 1) \cdot 10$ $\quad Tr_i := T(lambda_i)$

$trans := augment(lambda, Tr)$

$WRITEPRN("hrcsi_uvt.prn") := trans$

Define wavelength and mcp qe vector and qe matrix:

$i := 1 .. 791$

$lambda_i := 100 + (i - 1) \cdot 10$ $\quad QEv_i := QE(lambda_i)$

$qemcp := augment(lambda, QEv)$

$WRITEPRN("hrcs_uvmcpqe.prn") := qemcp$

Define wavelength and hrc-s qe vector and qe matrix:

$i := 1 .. 791$

$lambda_i := 100 + (i - 1) \cdot 10$ $\quad QEv_UVIS_i := QE_UVIS(lambda_i)$

$eff := augment(lambda, QEv_UVIS)$

$WRITEPRN("hrcsi_uvqe.prn") := eff$

We will estimate the count rate for a star with a blackbody spectrum.
The spectral photon irradiance for a star at temperature T_e and bolometric apparent magnitude m_b is given by

$$f(\lambda, T_e, m_b) := \frac{8.48 \cdot 10^{34} \cdot 10^{-0.4 \cdot m_b}}{T_e^{\,4} \cdot \lambda^4 \cdot \left(\exp\left(\frac{1.44 \cdot 10^8}{\lambda \cdot T_e} \right) - 1 \right)}$$ photons cm^{-2} s^{-1} A^{-1}

For an A0 star the bolometric correction is

$$BC := -0.40$$

and the effective temperature is

$$T_e := 10800$$

For an A0 star of visual apparent magnitude

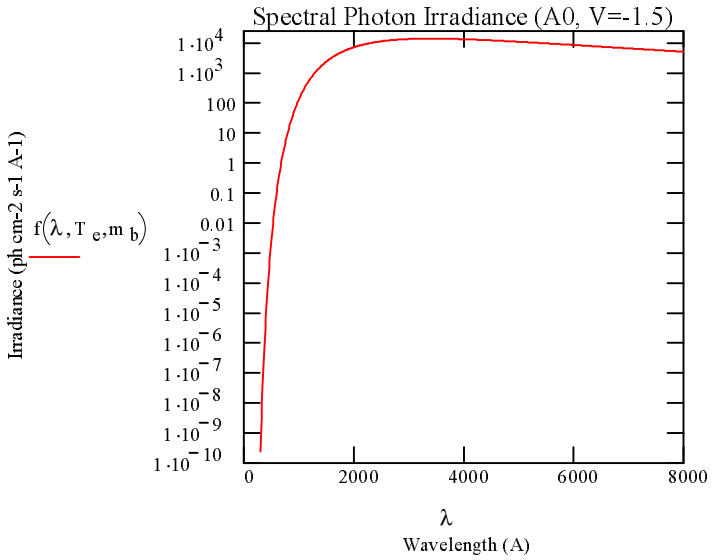
$$V := -1.5$$

The apparent bolometric magnitude is

$$m_b := BC + V \qquad m_b = -1.9$$

A plot of the spectral photon irradiance for this star:

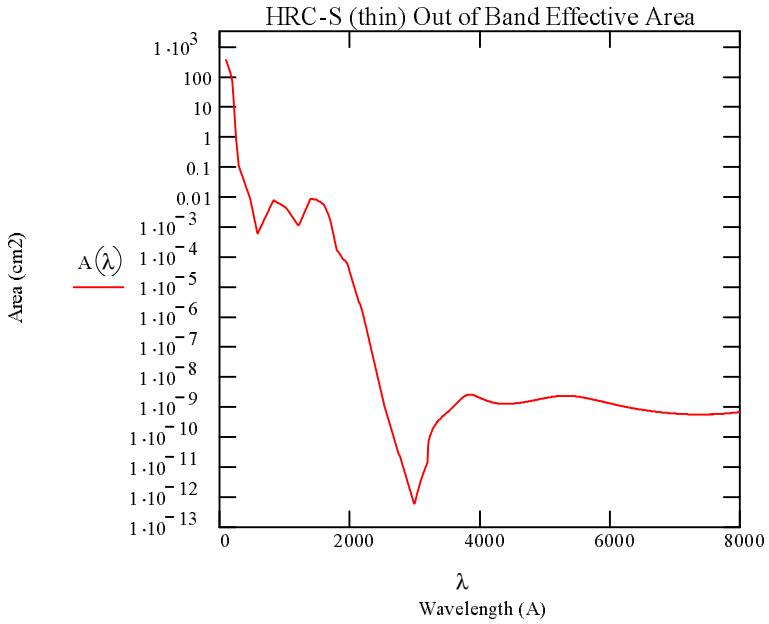
$$\lambda := 300, 310 .. 8000$$



The effective area of HRC-S is the product of the QE with the HRMA area (1100 cm^2):

$$A(\lambda) := QE_{UVIS}(\lambda) \cdot 1100$$

$$\lambda := 100, 110 .. 8000$$



Define wavelength and hrc-s qe vector and qe matrix:

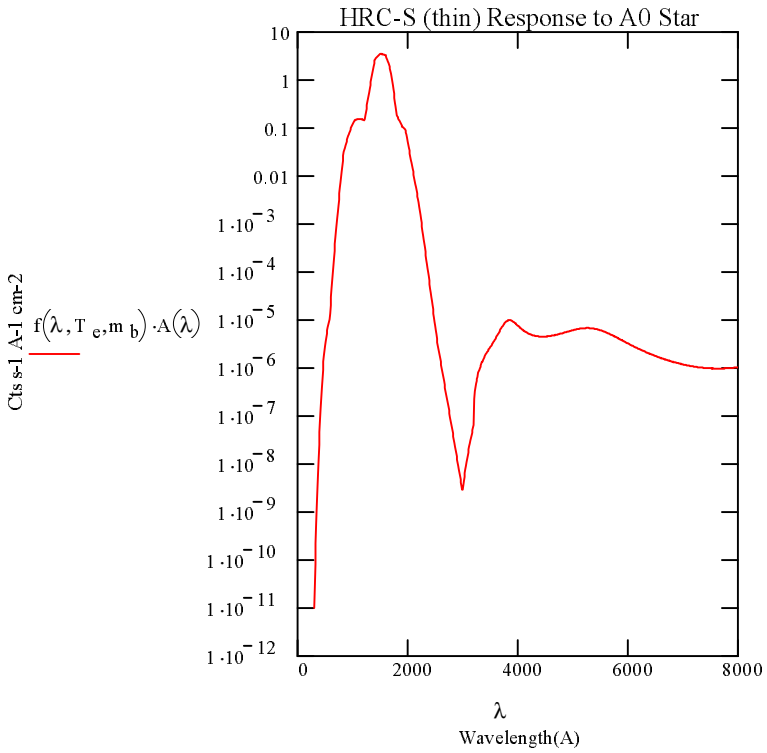
$i := 1 .. 791$

$lambda_i := 100 + (i - 1) \cdot 10$ $\qquad$ $Av_i := A(lambda_i)$

$effarea := augment(lambda, Av)$

$WRITEPRN("hrcso_uvar.prn") := effarea$

Folding the stellar spectrum with the area of HRC-S: $\lambda := 300, 310 .. 8000$



The estimated count rate for HRC-S in the band 300 - 8000 A is the area under this c

$$CR := \int_{300}^{8000} f(\lambda, T_e, m_b) \cdot QE_{UVIS}(\lambda) \cdot 1100 \, d\lambda \qquad CR = 1.14 \cdot 10^3 \quad \text{ct s}^{-1}$$

In 300-2500 and 2500-5000 A bands:

$$CR_{300_2500} := \int_{300}^{2500} f(\lambda, T_e, m_b) \cdot QE_{UVIS}(\lambda) \cdot 1100 \, d\lambda \qquad CR_{300_2500} = 1.137 \cdot 10^3 \quad \text{ct s}^{-1}$$

$$CR_{2500_8000} := \int_{2500}^{8000} f(\lambda, T_e, m_b) \cdot QE_{UVIS}(\lambda) \cdot 1100 \, d\lambda \qquad CR_{2500_8000} = 0.02 \quad \text{ct s}^{-1}$$

Response to solar radiation:

The spectral photon irradiance for a star at temperature T_e and bolometric apparent magnitude m_b is given by

$$f(\lambda, T_e, m_b) := \frac{8.48 \cdot 10^{34} \cdot 10^{-0.4 \cdot m_b}}{T_e^{4} \cdot \lambda^{4} \cdot \left(\exp\left(\frac{1.44 \cdot 10^{8}}{\lambda \cdot T_e} \right) - 1 \right)}$$ photons cm^{-2} s^{-1} A^{-1}

For the Sun, a G2 star, the effective temperature is

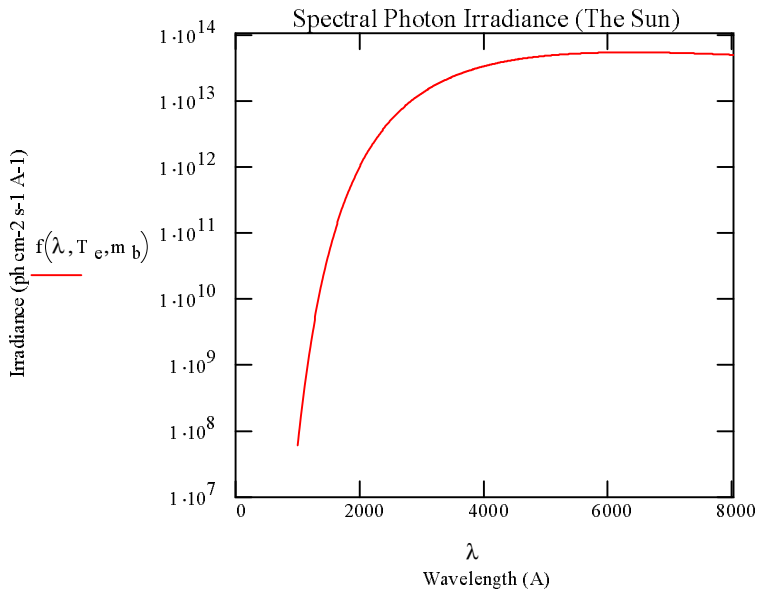
$$T_e := 5770$$

The apparent bolometric magnitude is

$$m_b := -26.82$$

A plot of the spectral photon irradiance of the Sun:

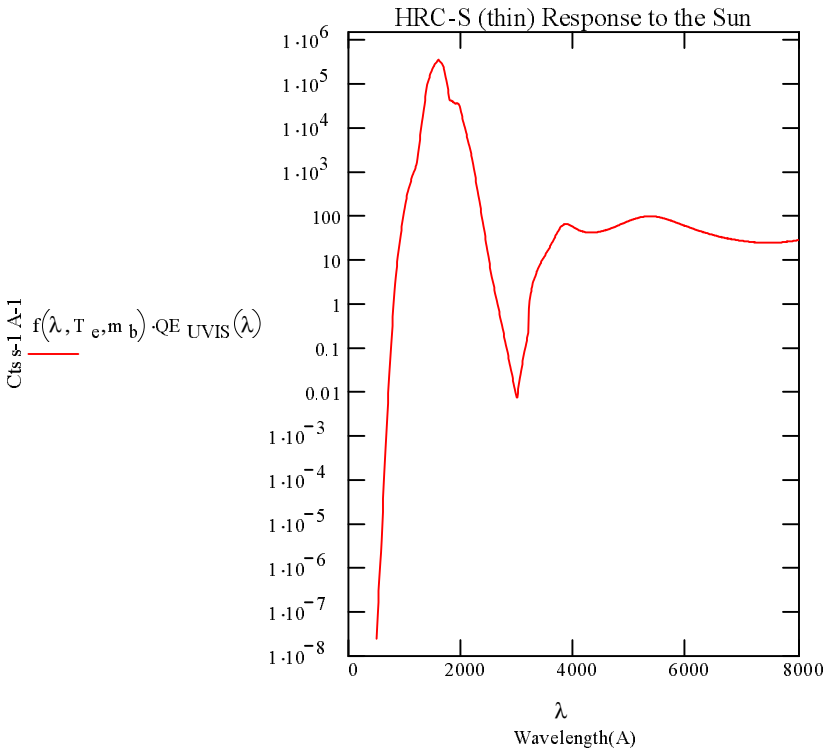
$$\lambda := 1000, 1010 .. 8000$$



The photon flux in the band 3000-8000:

$$\text{flux} := \int_{3000}^{8000} f(\lambda, T_e, m_b)\, d\lambda \qquad \text{flux} = 2.068 \cdot 10^{17}$$

$\lambda := 500, 510 .. 8000$



The HRC-S count rate density from the Sun:

$PST := 1 \cdot 10^{-12}$ (Point source transmission)

$$CR_{100_3000_Sun} := \int_{100}^{3000} PST \cdot f(\lambda, T_e, m_b) \cdot QE_{UVIS}(\lambda)\, d\lambda \qquad CR_{100_3000_Sun} = 6.638 \cdot 10^{-5}$$

ct cm^{-2} s^{-1}

$$CR_{3000_8000_Sun} := \int_{3000}^{8000} PST \cdot f(\lambda, T_e, m_b) \cdot QE_{UVIS}(\lambda)\, d\lambda \qquad CR_{3000_8000_Sun} = 1.642 \cdot 10^{-7}$$

ct cm^{-2} s^{-1}

Count rates from principle emission lines:

H I 1215.67 A

$$\phi_{1215} := \frac{1215.67 \cdot 10^{-8} \cdot 51 \cdot 10^{-4} \cdot 10^{-4} \cdot 10^{7}}{6.626 \cdot 10^{-27} \cdot 3 \cdot 10^{10}} \quad \phi_{1215} = 3.119 \cdot 10^{11} \quad \text{ph s}^{-1}\ \text{cm}^{-2}$$

$$CR_{1215} := QE_{UVIS}(1215.7) \cdot \phi_{1215} \cdot PST \quad CR_{1215} = 1.41 \cdot 10^{-7} \quad \text{ct s}^{-1}\ \text{cm}^{-2}$$

He II 303.8 A

$$\phi_{304} := \frac{303.8 \cdot 10^{-8} \cdot 2.5 \cdot 10^{-4} \cdot 10^{-4} \cdot 10^{7}}{6.626 \cdot 10^{-27} \cdot 3 \cdot 10^{10}} \quad \phi_{304} = 3.821 \cdot 10^{9} \quad \text{ph s}^{-1}\ \text{cm}^{-2}$$

$$CR_{304} := QE_{UVIS}(304) \cdot \phi_{304} \cdot PST \quad CR_{304} = 1.26 \cdot 10^{-7} \quad \text{cts s}^{-1}\ \text{cm}^{-2}$$

H I 1025.72 A

$$\phi_{1026} := \frac{1025.72 \cdot 10^{-8} \cdot 0.60 \cdot 10^{-4} \cdot 10^{-4} \cdot 10^{7}}{6.626 \cdot 10^{-27} \cdot 3 \cdot 10^{10}} \quad \phi_{1026} = 3.096 \cdot 10^{9} \quad \text{ph s}^{-1}\ \text{cm}^{-2}$$

$$CR_{1026} := QE_{UVIS}(1026) \cdot \phi_{1026} \cdot PST \quad CR_{1026} = 5.245 \cdot 10^{-9} \quad \text{cts s}^{-1}\ \text{cm}^{-2}$$

C III 977 A

$$\phi_{977} := \frac{977 \cdot 10^{-8} \cdot 0.50 \cdot 10^{-4} \cdot 10^{-4} \cdot 10^{7}}{6.626 \cdot 10^{-27} \cdot 3 \cdot 10^{10}} \quad \phi_{977} = 2.457 \cdot 10^{9} \quad \text{ph s}^{-1}\ \text{cm}^{-2}$$

$$CR_{977} := QE_{UVIS}(977) \cdot \phi_{977} \cdot PST \quad CR_{977} = 4.88 \cdot 10^{-9} \quad \text{cts s}^{-1}\ \text{cm}^{-2}$$

Count rate estimates from several bright stars.

Spectra in the range 1200 - 3350 A have been retrieved from the IUE archive of calibrated low dispersion spectra. The visible spectra 3500 - 7000 A have been derived from calibrated spectra of parent type spectral type stars in Jacoby, Hunter, & Christian, 1984, AP J supp. **56**, 257. The parent spectra has been scaled in order to match the observed IUE spectra. The gap between 3350 A and 3500 A has been linearly interpolated.

Betelgeuse (M1-2Ia star; U=4.41 B=2.35 V=0.5)

Importing the star's spectrum: ORIGIN := 0

b_spectrum := READPRN("betelgeusespect.prn")

wavel := $b_spectrum^{<0>}$ A intensity := $b_spectrum^{<1>}$ erg s^{-1} cm^{-2} A^{-1}

Linear interpolation to create a continuous intensity function:

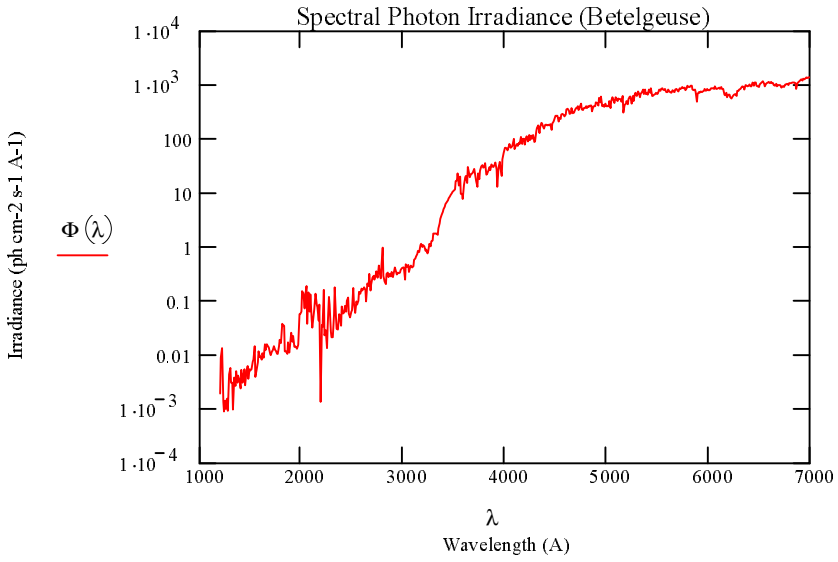
I(λ) := linterp(wavel, intensity, λ)

with h := $6.6261 \cdot 10^{-27}$ erg s c := $2.998 \cdot 10^{10}$ cm s^{-1}

the photon irradiance is given by

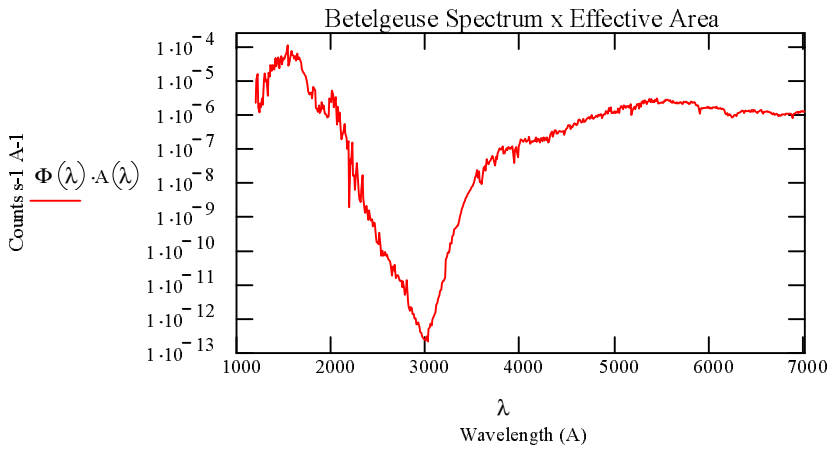
$$\Phi(\lambda) := I(\lambda) \cdot \left(\frac{\lambda \cdot 10^{-8}}{h \cdot c} \right)$$ photons cm^{-2} s^{-1} A^{-1}

A plot of the spectral photon irradiance: λ := 1200, 1210.. 7000



Effective area model convolved with stellar spectrum to obtain count rate:

$\lambda := 1200, 1210 .. 7000$



Calculate count rate in various spectral bands:

$$\int_{1200}^{3000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 7.376\cdot 10^{-3} \quad \text{ct s}^{-1}$$

$$\int_{3000}^{4000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 1.677\cdot 10^{-5} \quad \text{ct s}^{-1}$$

$$\int_{4000}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 1.788\cdot 10^{-3} \quad \text{ct s}^{-1}$$

$$\int_{1200}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 9.112\cdot 10^{-3} \quad \text{ct s}^{-1}$$

Note: ROSAT HRI count rate: < 0.0005 ct s^{-1}

Beta Aurigae (A2 V star; U=1.98 B=1.93 V=1.85)

Importing the star's spectrum: ORIGIN := 0

b_spectrum := READPRN("betaaurspect.prn")

wavel := $b_spectrum^{<0>}$ A intensity := $b_spectrum^{<1>}$ erg s^{-1} cm^{-2} A^{-1}

Linear interpolation to create a continuous intensity function:

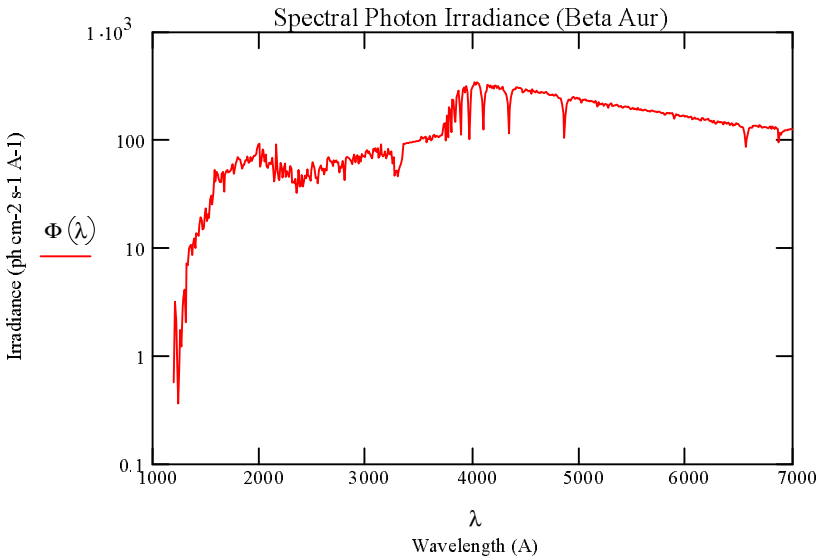
$I(\lambda) := linterp(wavel, intensity, \lambda)$

with $h := 6.6261 \cdot 10^{-27}$ erg s $c := 2.998 \cdot 10^{10}$ cm s^{-1}

the photon irradiance is given by

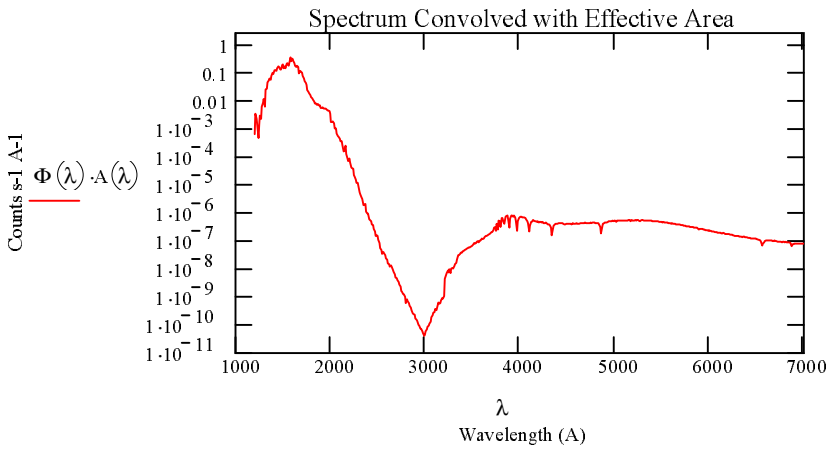
$$\Phi(\lambda) := I(\lambda) \cdot \left(\frac{\lambda \cdot 10^{-8}}{h \cdot c} \right)$$ photons cm^{-2} s^{-1} A^{-1}

A plot of the spectral photon irradiance: $\lambda := 1200, 1210 .. 7000$



Effective area model convolved with stellar spectrum to obtain count rate:

$\lambda := 1200, 1210 .. 7000$



Calculate count rate in various spectral bands:

$$\int_{1200}^{3000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 2.6\cdot 10^{1} \quad \text{ct s}^{-1}$$

$$\int_{3000}^{4000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 1.06\cdot 10^{-4} \quad \text{ct s}^{-1}$$

$$\int_{4000}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 6.321\cdot 10^{-4} \quad \text{ct s}^{-1}$$

$$\int_{1200}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 2.6\cdot 10^{1} \quad \text{ct s}^{-1}$$

Note: ROSAT HRI count rate: 0.0078 ct s^{-1}

Beta Carinae (A2 IV star; U=1.65 B=1.68 V=1.70)

Importing the star's spectrum: ORIGIN := 0

b_spectrum := READPRN("betacarspect.prn")

wavel := $b_spectrum^{<0>}$ A intensity := $b_spectrum^{<1>}$ erg s^{-1} cm^{-2} A^{-1}

Linear interpolation to create a continuous intensity function:

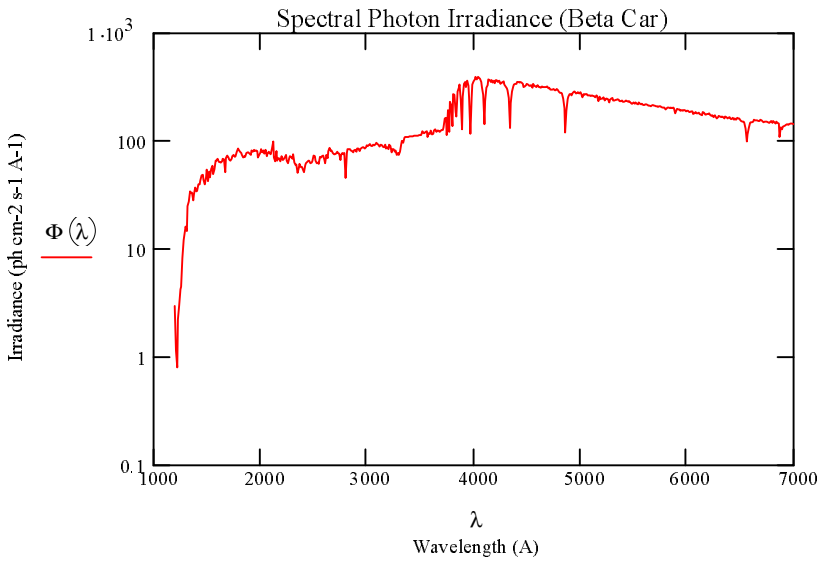
$I(\lambda) := linterp(wavel, intensity, \lambda)$

with $h := 6.6261 \cdot 10^{-27}$ erg s $c := 2.998 \cdot 10^{10}$ cm s^{-1}

the photon irradiance is given by

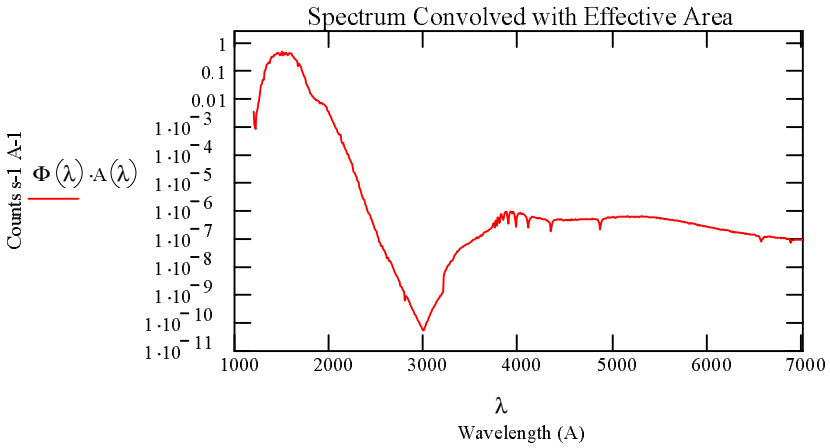
$$\Phi(\lambda) := I(\lambda) \cdot \left(\frac{\lambda \cdot 10^{-8}}{h \cdot c} \right)$$ photons cm^{-2} s^{-1} A^{-1}

A plot of the spectral photon irradiance for: $\lambda := 1200, 1210 .. 7000$



Effective area model convolved with stellar spectrum to obtain count rate:

$\lambda := 1200, 1210 .. 7000$



Calculate count rate in various spectral bands:

$$\int_{1200}^{3000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 51.496 \quad \text{ct s}^{-1}$$

$$\int_{3000}^{4000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 1.219\cdot 10^{-4} \quad \text{ct s}^{-1}$$

$$\int_{4000}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 7.258\cdot 10^{-4} \quad \text{ct s}^{-1}$$

$$\int_{1200}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 51.521 \quad \text{ct s}^{-1}$$

Note: ROSAT HRI count rate: 0.0111 ct s^{-1}

Rigel (B8 lab star; U=-0.57 B=0.09 V=0.12)

Importing the star's spectrum: ORIGIN := 0

b_spectrum := READPRN("rigelspect.prn")

wavel := $b_spectrum^{<0>}$ A intensity := $b_spectrum^{<1>}$ erg s^{-1} cm^{-2} A^{-1}

Linear interpolation to create a continuous intensity function:

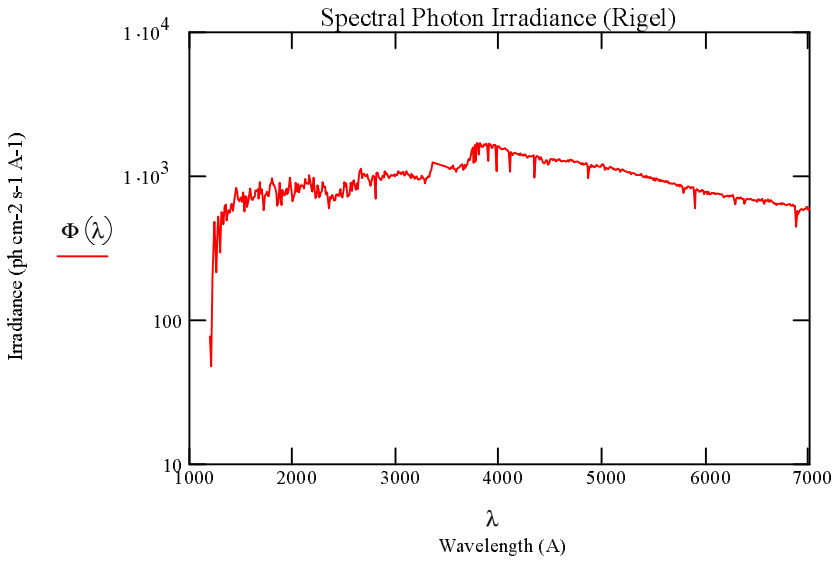
$I(\lambda) := linterp(wavel, intensity, \lambda)$

with $h := 6.6261 \cdot 10^{-27}$ erg s $c := 2.998 \cdot 10^{10}$ cm s^{-1}

the photon irradiance is given by

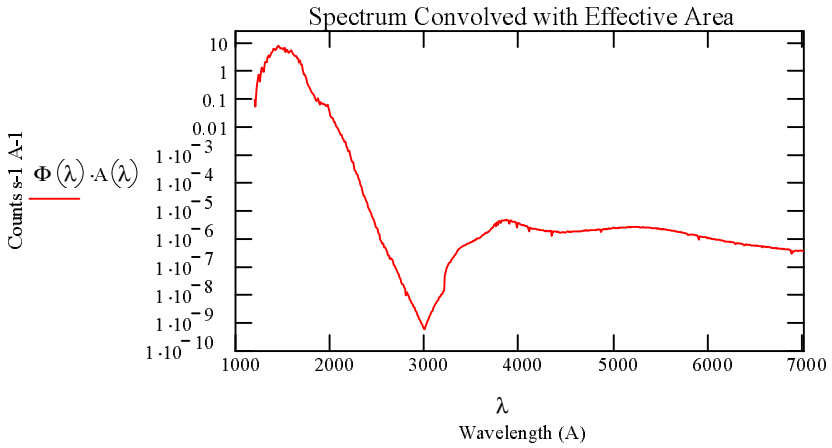
$$\Phi(\lambda) := I(\lambda) \cdot \left(\frac{\lambda \cdot 10^{-8}}{h \cdot c} \right)$$ photons cm^{-2} s^{-1} A^{-1}

A plot of the spectral photon irradiance: $\lambda := 1200, 1210 .. 7000$



Effective area model convolved with stellar spectrum to obtain count rate:

$\lambda := 1200, 1210 .. 7000$



Calculate count rate in various spectral bands:

$$\int_{1200}^{3000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 757.395 \quad \text{ct s}^{-1}$$

$$\int_{3000}^{4000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 1.005\cdot 10^{-3} \quad \text{ct s}^{-1}$$

$$\int_{4000}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 3.18\cdot 10^{-3} \quad \text{ct s}^{-1}$$

$$\int_{1200}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 757.352 \quad \text{ct s}^{-1}$$

Note: ROSAT HRI count rate: 0.1960 ct s^{-1}

Vega (A0 V star; U=0.02 B=0.03 V=0.03)

ORIGIN := 0

Importing the star's spectrum:

b_spectrum := READPRN("vegaspect.prn")

wavel := $b_spectrum^{<0>}$ A intensity := $b_spectrum^{<1>}$ erg s^{-1} cm^{-2} A^{-1}

Linear interpolation to create a continuous intensity function:

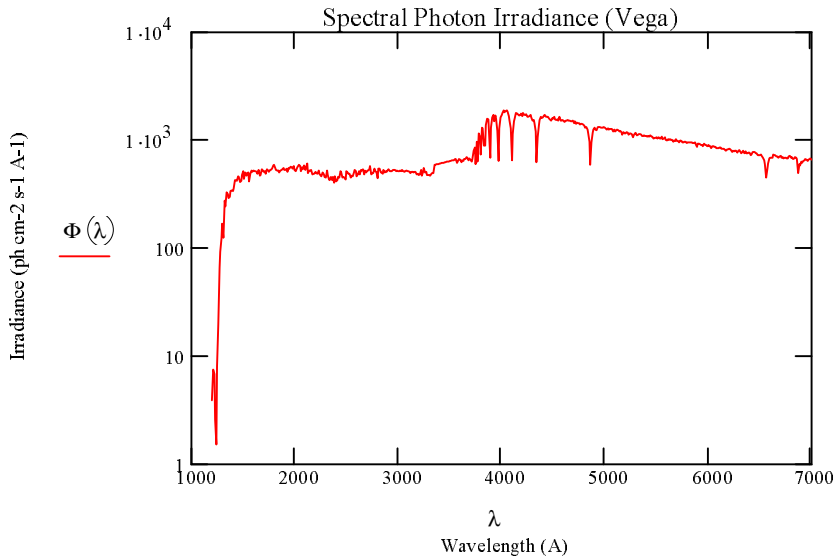
$I(\lambda) := linterp(wavel, intensity, \lambda)$

with $h := 6.6261 \cdot 10^{-27}$ erg s $c := 2.998 \cdot 10^{10}$ cm s^{-1}

the photon irradiance is given by

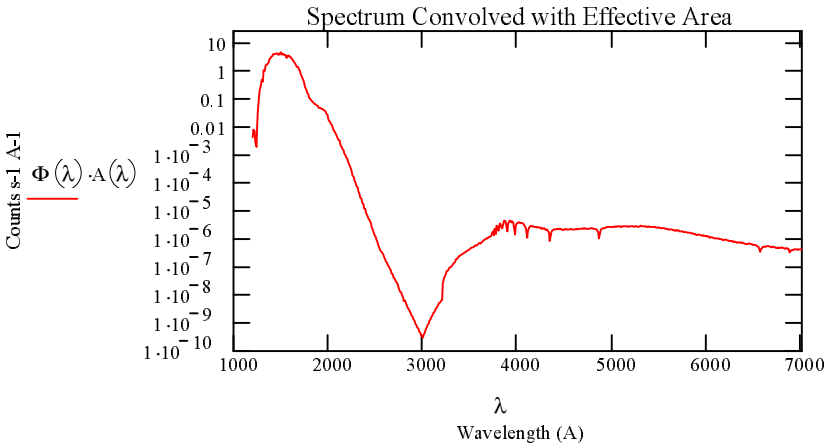
$$\Phi(\lambda) := I(\lambda) \cdot \left(\frac{\lambda \cdot 10^{-8}}{h \cdot c} \right)$$ photons cm^{-2} s^{-1} A^{-1}

A plot of the spectral photon irradiance: $\lambda := 1200, 1210 .. 7000$



Effective area model convolved with stellar spectrum to obtain count rate:

$\lambda := 1200, 1210 .. 7000$



Calculate count rate in various spectral bands:

$$\int_{1200}^{3000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 460.258 \quad \text{ct s}^{-1}$$

$$\int_{3000}^{4000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 7.064\cdot 10^{-4} \quad \text{ct s}^{-1}$$

$$\int_{4000}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 3.422\cdot 10^{-3} \quad \text{ct s}^{-1}$$

$$\int_{1200}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 459.485 \quad \text{ct s}^{-1}$$

Note: ROSAT HRI count rate: 0.0937 ct s^{-1}

Zeta Aquilae (A0 V star; U=2.99 B=3.00 V=2.99)

ORIGIN := 0

Importing the star's spectrum:

b_spectrum := READPRN("zetaaqlspect.prn")

wavel := $b_spectrum^{<0>}$ A intensity := $b_spectrum^{<1>}$ erg s^{-1} cm^{-2} A^{-1}

Linear interpolation to create a continuous intensity function:

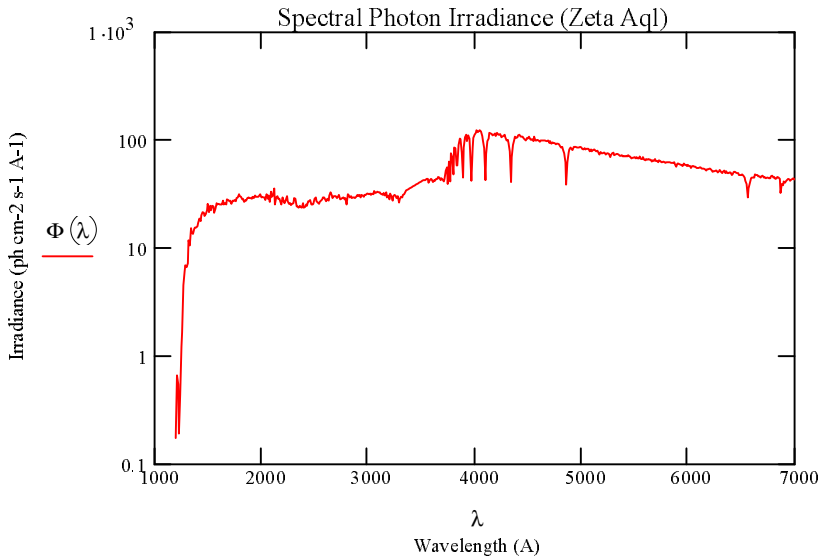
$I(\lambda) := linterp(wavel, intensity, \lambda)$

with $h := 6.6261 \cdot 10^{-27}$ erg s $c := 2.998 \cdot 10^{10}$ cm s^{-1}

the photon irradiance is given by

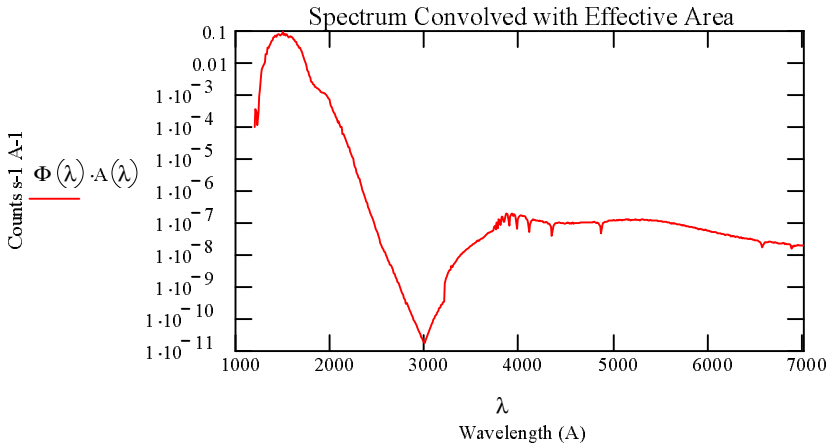
$$\Phi(\lambda) := I(\lambda) \cdot \left(\frac{\lambda \cdot 10^{-8}}{h \cdot c} \right)$$ photons cm^{-2} s^{-1} A^{-1}

A plot of the spectral photon irradiance: $\lambda := 1200, 1210 .. 7000$



Effective area model convolved with stellar spectrum to obtain count rate:

$\lambda := 1200, 1210 .. 7000$



Calculate count rate in various spectral bands:

$$\int_{1200}^{3000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 2.3\cdot 10^{1} \quad \text{ct s}^{-1}$$

$$\int_{3000}^{4000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 4.603\cdot 10^{-5} \quad \text{ct s}^{-1}$$

$$\int_{4000}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 2.216\cdot 10^{-4} \quad \text{ct s}^{-1}$$

$$\int_{1200}^{7000} \Phi(\lambda)\cdot A(\lambda)\,d\lambda = 2.3\cdot 10^{1} \quad \text{ct s}^{-1}$$

Note: ROSAT HRI count rate: <0.0042 ct s^{-1}

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