XMM-Newton Optical & UV Monitor (OM) Calibration

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Users Group Meeting
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Optical Monitor data processing & calibration

I) Instrumental corrections

- Astrometry(filters & grisms):
  - Geometric distortion, Boresight
  - ➢ *X,Y linearized positions*
- Photometry:
  - aperture
  - PSF
  - coincidence losses and dead time
  - ***time sensitivity degradation***
  - cosmetic (bad pixels)
  - ➢ *count rate (vs. time)*
- Spectroscopy:
  - geometry:distortion, rotation
  - spectral extraction
  - ➢ *spectrum count rate vs. position*

II) Calibration

- Astrometry:
  - ➢ *from X,Y to R.A. & Dec*
- Photometry:
  - ➢ *from count rate to magnitude, standard UBV, color indices, AB magnitude*
  - ➢ *light curve*
  - ➢ *from count rate to absolute flux at effective wavelength of filter*
- Spectroscopy:
  - ➢ *from position to wavelength*
  - ➢ *from count rate to absolute flux vs. wavelength*

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All corrections and calibrations are included into OM data processing through corresponding SAS algorithms & CCFs

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SAS RESULTS CAN BE USED DIRECTLY FOR SCIENTIFIC INTERPRETATION

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AB magnitude system for OM

AB magnitudes in the UV: OM versus Galex

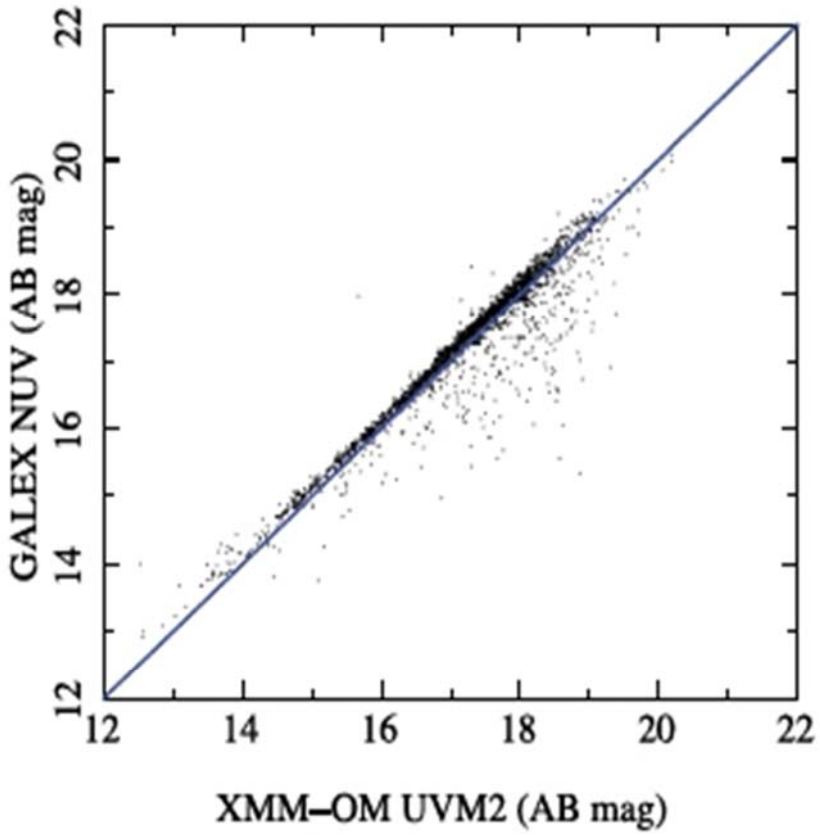


Figure 7. Comparison of the XMM-OM *UVM2* and *GALEX* NUV magnitudes. A good linear correlation between magnitudes in the two passbands is evident. The blue line corresponds to a one-to-one relation between *UVM2* and NUV.

M.N.R.A.S., 426, 903 (2012

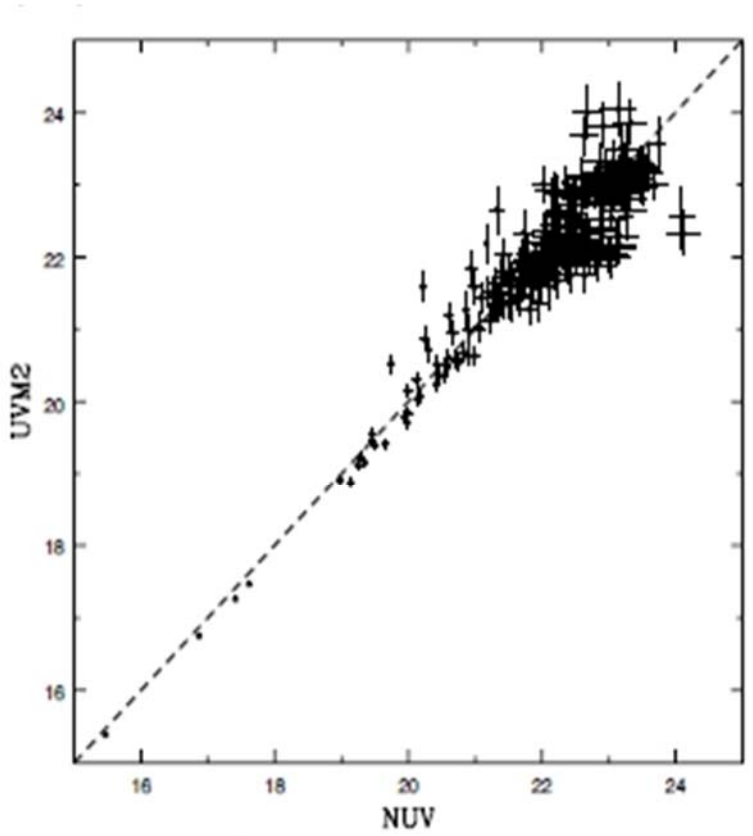
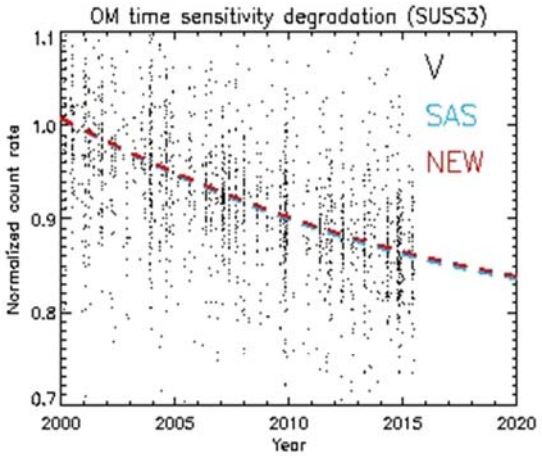
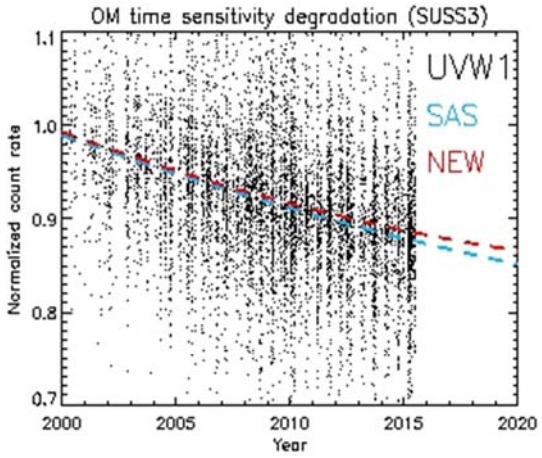


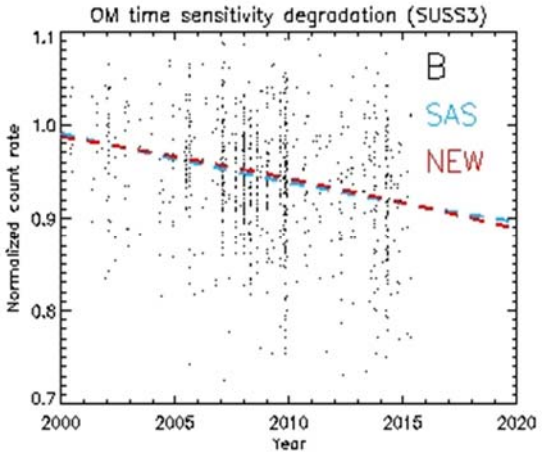
Fig. 6. XMM-OM *UVM2* magnitudes versus GALEX *NUV* magnitudes diagram. The dashed line indicates the equality of the two magnitudes. Error bars represent one standard-deviation photometric uncertainty.

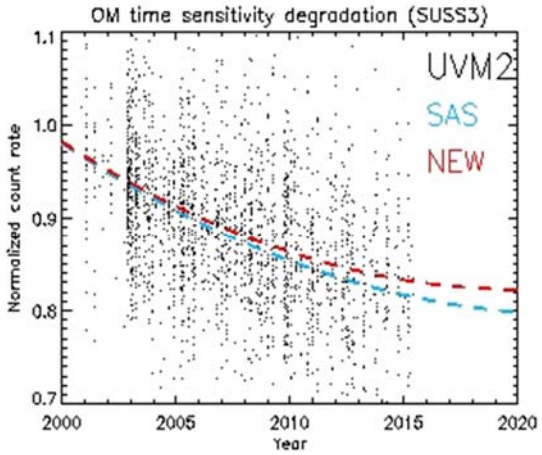
A&A 574, A49 (2015)

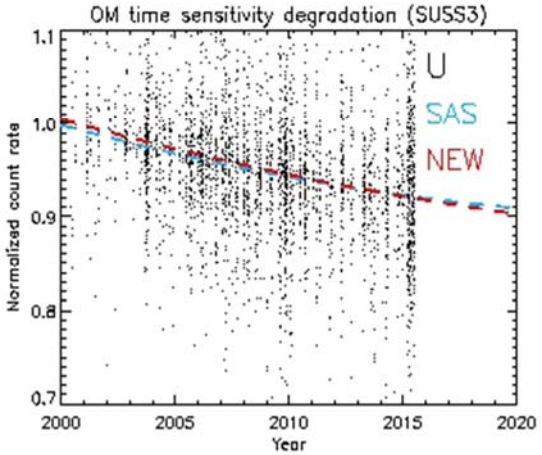
OM time sensitivity degradation

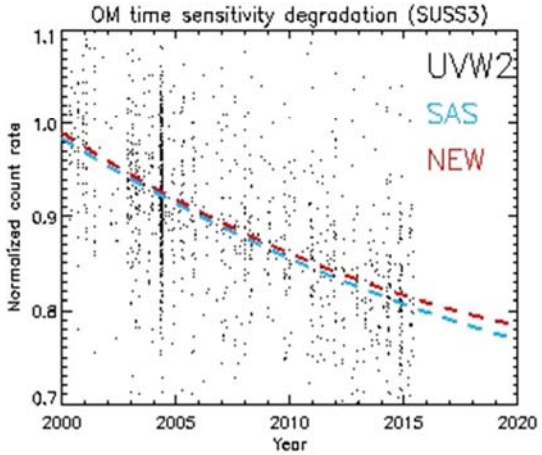












OM throughput

Filter	Current	Expected in 2030
UVW2	0.79	0.73
UVM2	0.81	0.79
UVW1	0.87	0.84
U	0.92	0.90
B	0.92	0.86
V	0.85	0.81

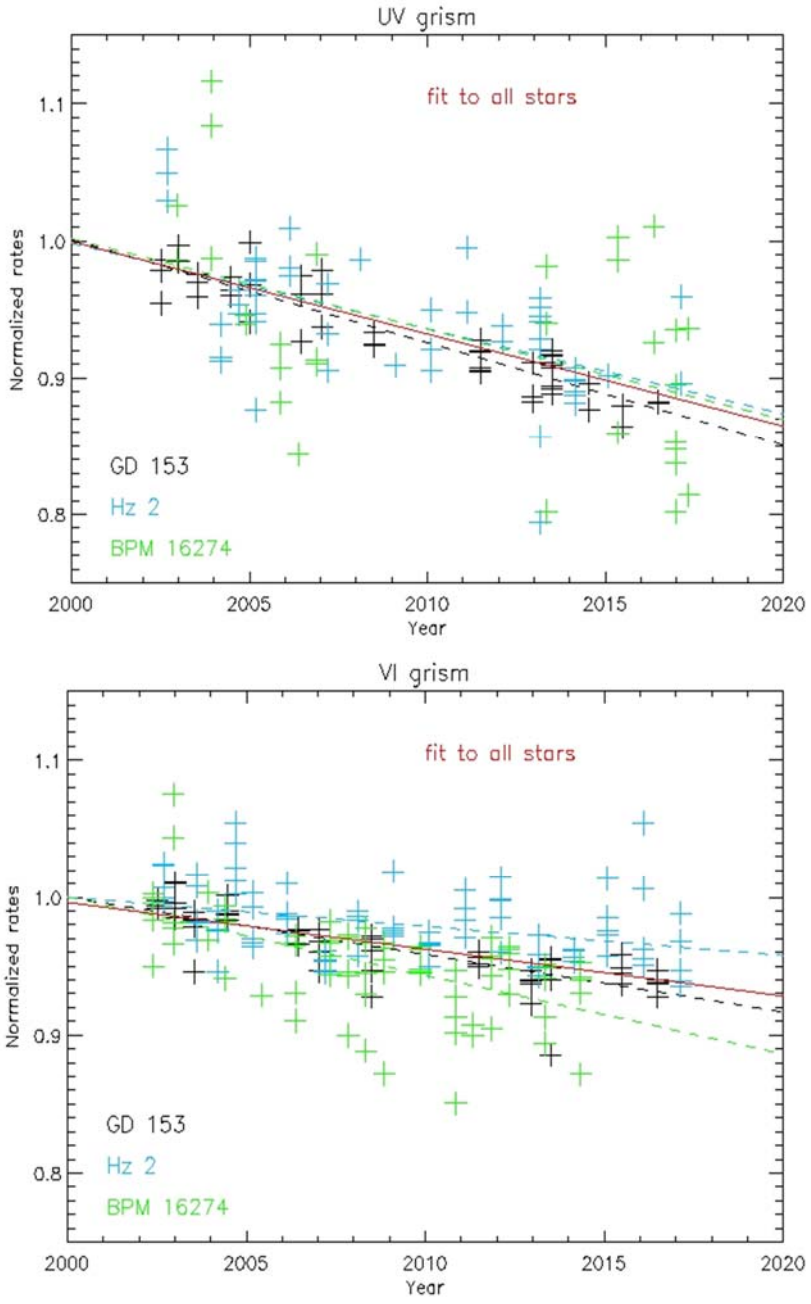
Based on repeated (> 5) observations of sources in the OM Catalogue SUSS.3

OM data processing in SAS 17

- Repeatability of OM filter photometry: measured mean rates (c/s) of standard stars

Star	Nobs	UVW2	UVM2	UVW1	U	B	V
GD 153	15	83.29	161.89	330.03	420.25	283.69	71.57
error (%)		1.5	1.5	1.0	1.4	1.0	2.4
Hz 2	18	23.81	48.27	111.78	168.71	148.83	43.84
error (%)		2.1	1.3	1.3	0.9	0.8	3.0
BPM 16274	34	14.75	30.34	72.96	112.62	107.81	33.04
error (%)		1.8	1.2	1.0	0.8	0.9	2.4

OM time sensitivity degradation in OM Grisms

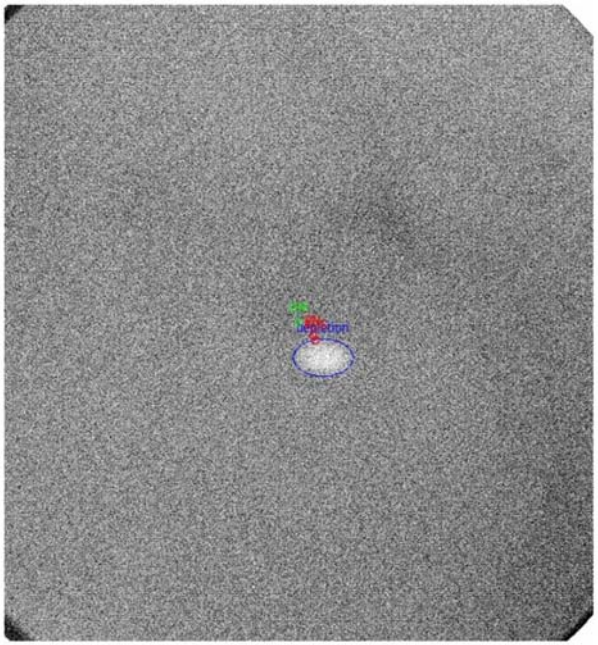


To measure the variation, spectra of Standard stars are binned in 250 A (UV Grism) and 300 A (V Grism) and normalized

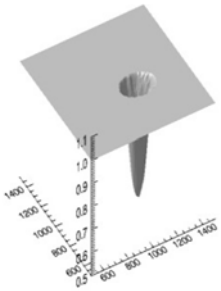
Year	UV_Grism	V_Grism
2000	1.00	1.00
2002	1.01	1.01
2004	1.02	1.02
2006	1.04	1.02
2008	1.05	1.03
2010	1.07	1.04
2012	1.08	1.04
2014	1.10	1.05
2016	1.12	1.06
2018	1.13	1.07
2020	1.15	1.07

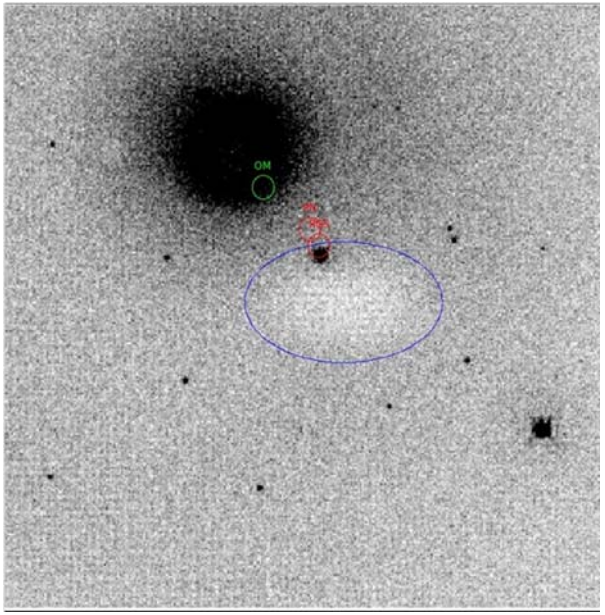
Correction factors for OM grism spectra

Jupiter Depletion patch



Flat field image (full frame)





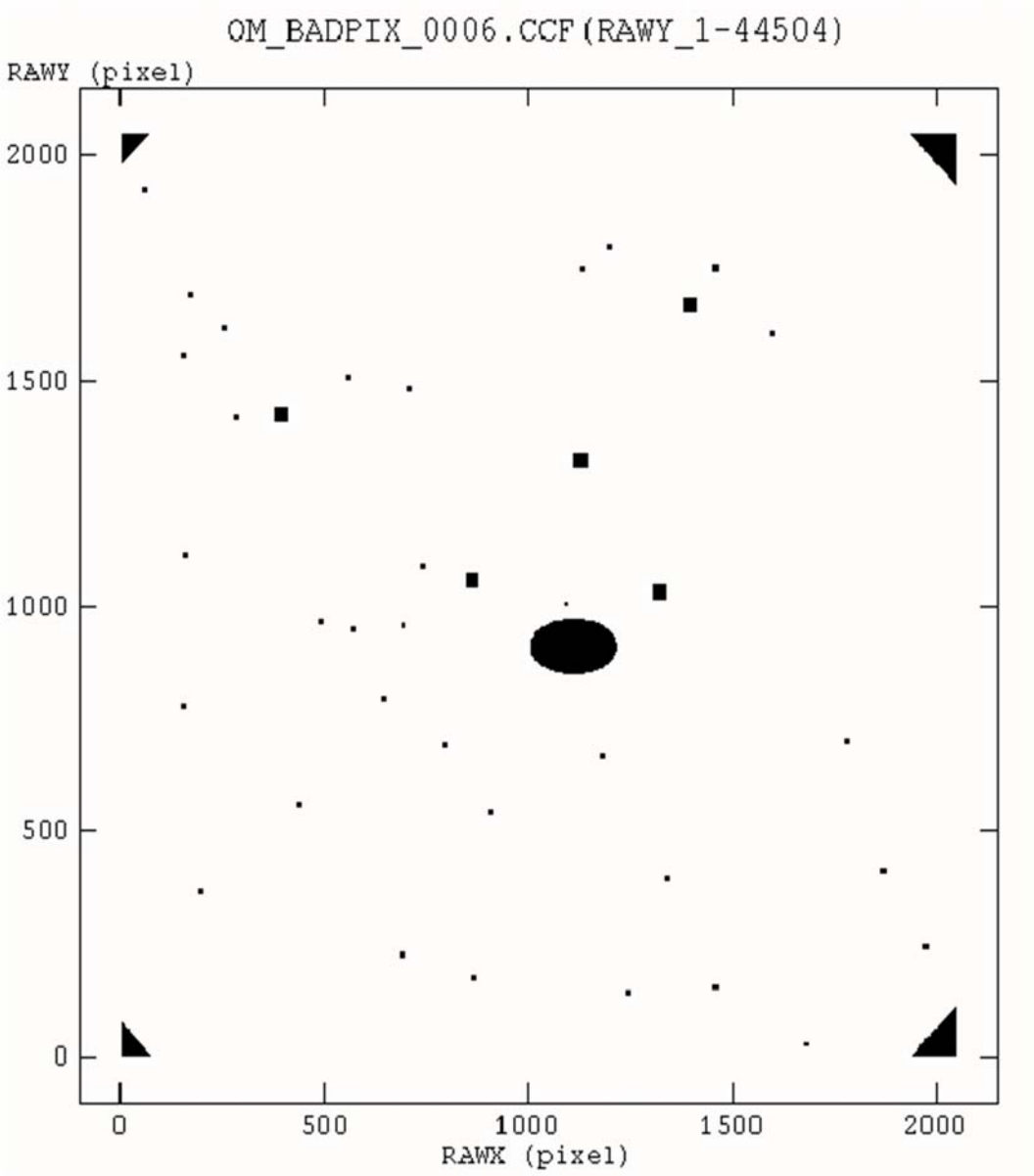
Science image V filter (small window)

Jupiter was accidentally observed in July 2017 with the V filter :

- a low sensitivity depletion patch appeared in the OM detector: ~160 x 80 pix2
- RGS boresight is depleted (5% in V filter)
- the depletion level is wavelength dependent
- it is stable (54 % in flat field)
- the affected area is flagged in the Bad Pixels CCF
- photometry with SAS: standard star Hz 2 located in the center of the patch:

Filter	V	B	U	UVW1	UVM2	UVW2
Rate loss	0.73	0.88	0.97	0.91	0.90	0.88
Sky loss	0.80	0.92	0.95	0.90	0.86	0.87

New Bad pixels map



Bad pixels:

- Dead pixels
- Low sensitivity pixels
- Low sensitivity patches
- “noisy” corners
- Jupiter depletion patch

Are used by SAS to set quality flags on the extracted sources

XMM-Newton Serendipitous UV Source Survey (a.k.a. "the OM Catalogue")

- Version 3: SUSS3, released in 2017
- All observations till July 2015
- 6.88 Msources from 7,886 XMM-Newton pointings (4,8 Msources unique)
- 3.4 Msources with UV data
- 3-colour data across the Galex NUV band.
- simultaneous X-ray and optical data.
- source variability from multiple exposures and pointings (0,9Msources repeated)
- Full reprocessing with SAS 15: corrected photometry of sources detected in mosaic and stacked images,…
- 84 % coincidence with Gaia DR1

- New Version 4: SUSS4
- To be released at end 2018
- All public observations till mid-2017 + calibration observations: ~10200 XMM-Newton pointings
- Full reprocessing with SAS 17: new time sensitivity degradation.

➢ **available through the ESA XSA**

➢ ***+ Suppl. Bright sources catalogue***