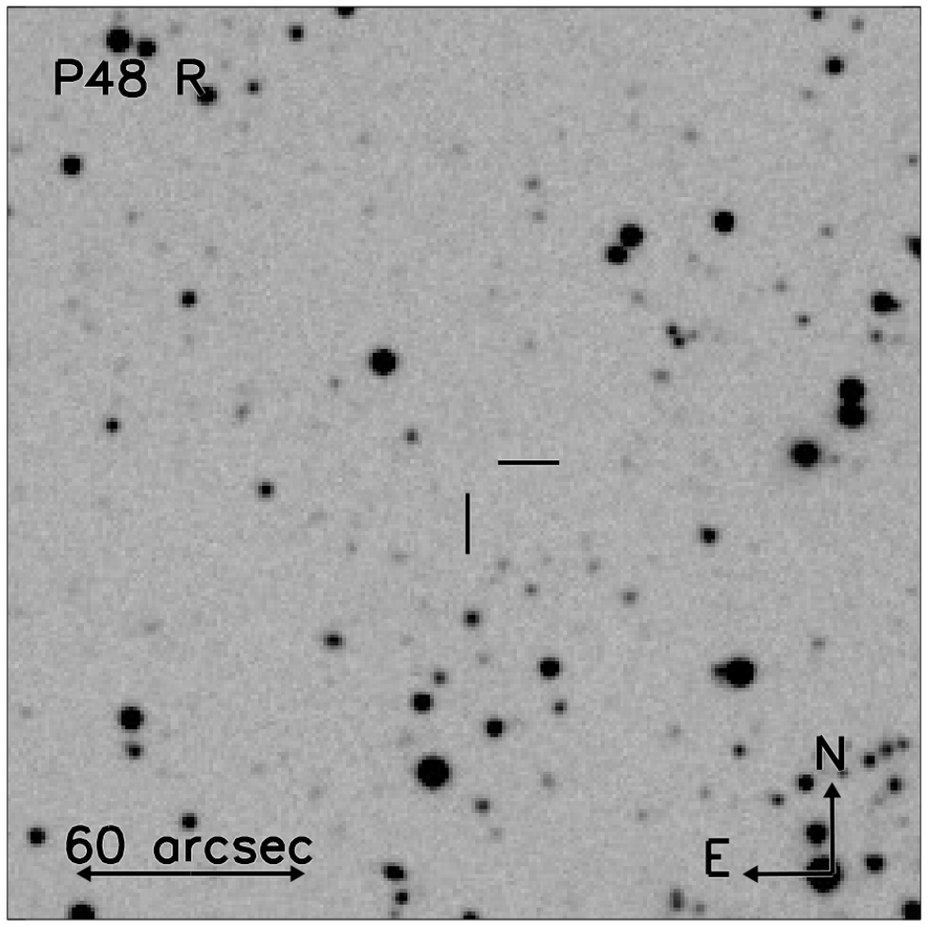
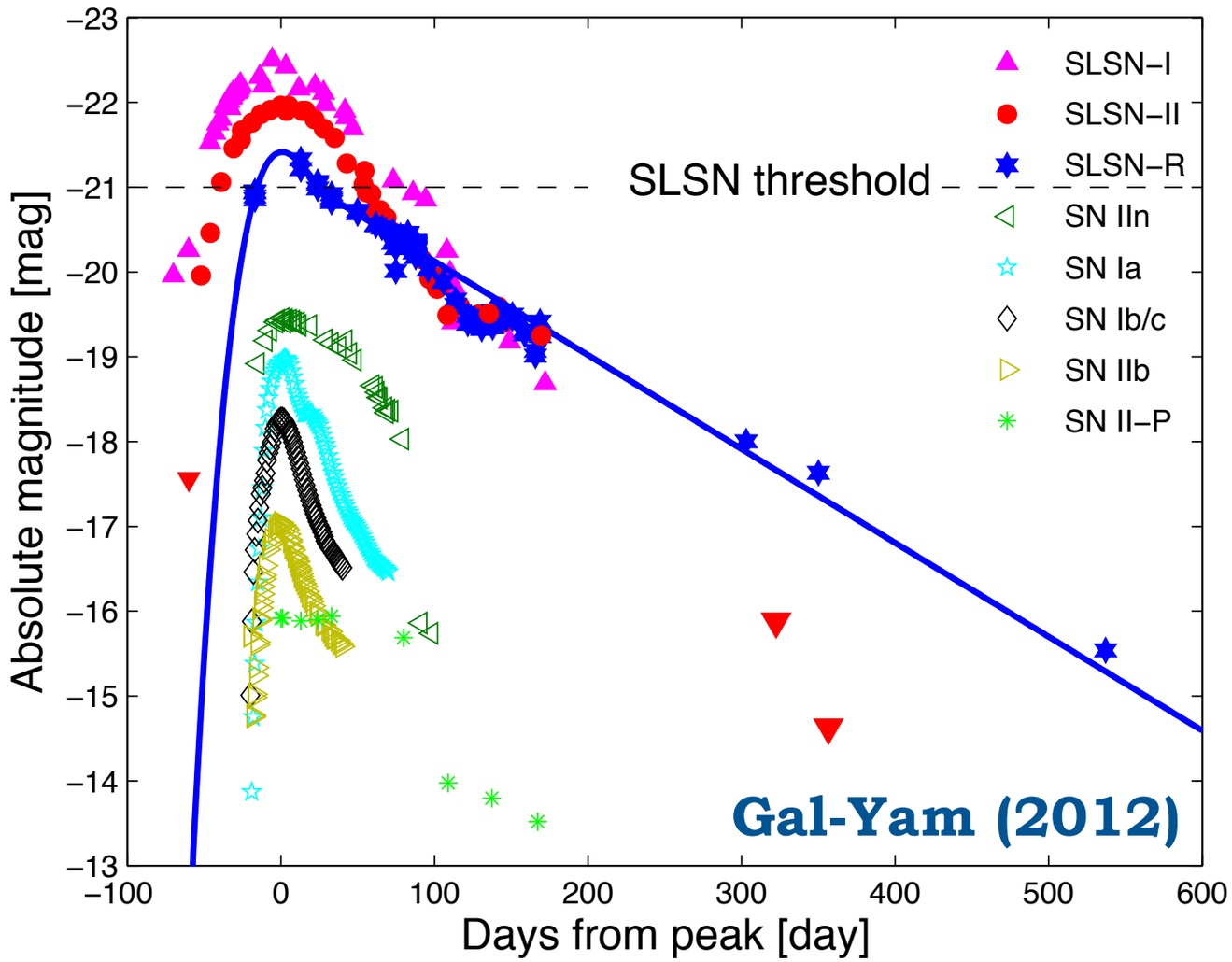
iPTF13ajg: a hydrogen-poor superluminous supernova at z=0.74



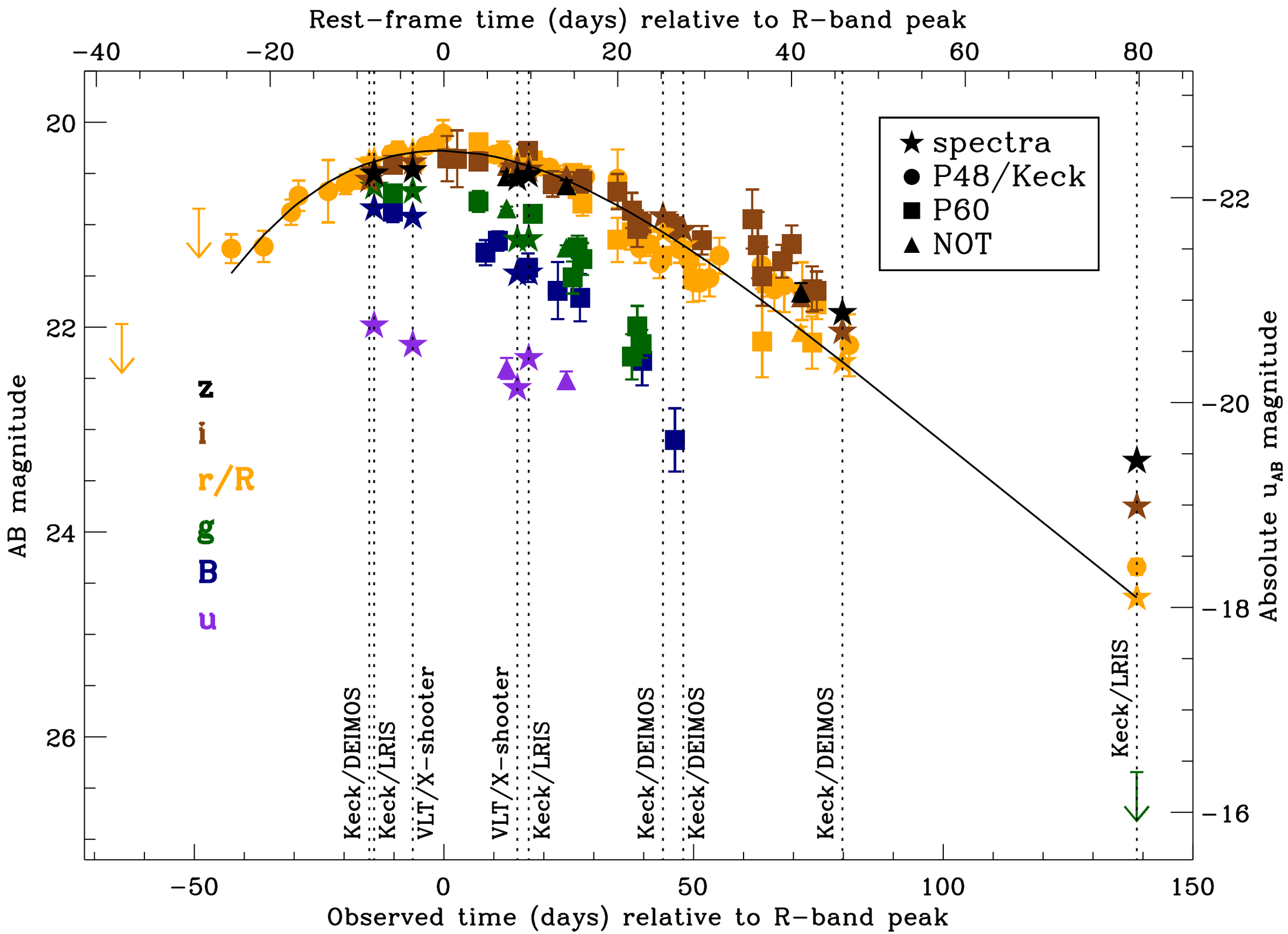


Paul Vreeswijk (Weizmann), Sandra Savaglio (MPE), Avishay Gal-Yam (Weizmann), Annalisa De Cia (Weizmann), Robert Quimby (Kavli IPMU), Mark Sullivan (Southhampton), Brad Cenko (GSFC), Dan Perley (Caltech), Adam Rubin (Weizmann), Iair Arcavi (LCOGT/KITP)
+ iPTF collaboration

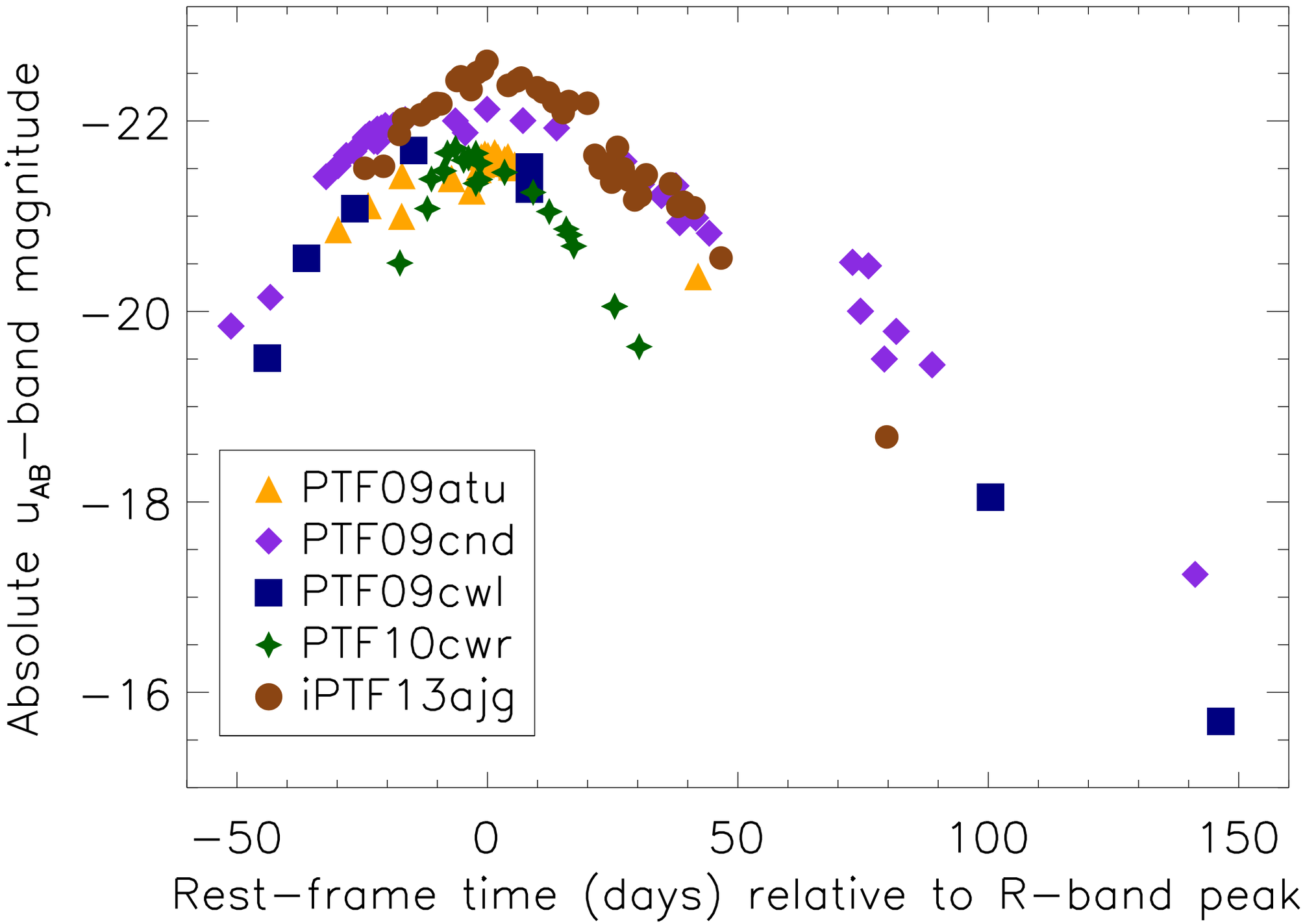
Hydrogen-poor SLSNe

- discovered thanks to non-targeted SN surveys probing a large volume: PTF, CRTS, PANSTARRS
- typical redshift: z~0.3, up to z~4 (e.g. **Cooke et al. 2012**)
- rare: ~10^{-8} Mpc^{-3} yr^{-1} vs. ~10^{-5} Mpc^{-3} yr^{-1} CCSNe
- extremely bright transients, with L_{peak}~10^{44} erg/s and E_{rad}~10^{51} erg (see **Gal-Yam et al. 2012**)
- low luminosity, low stellar-mass host galaxies, with high specific SFR (see **Lunnan et al. 2013**)
- energy source debated: interaction with circumstellar shell? magnetar?

Lightcurves of iPTF13ajg

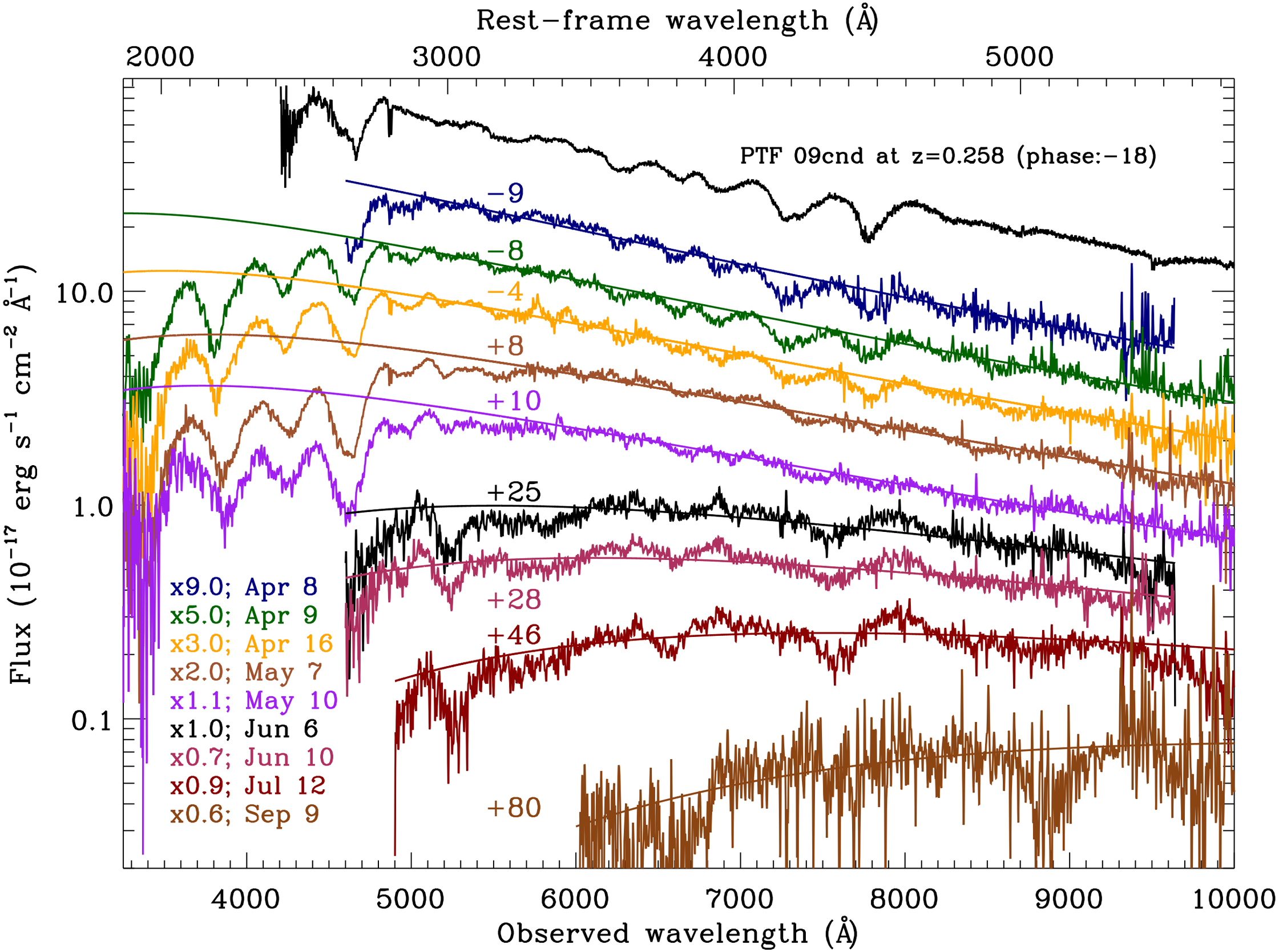


Absolute lightcurves of type I SLSNe

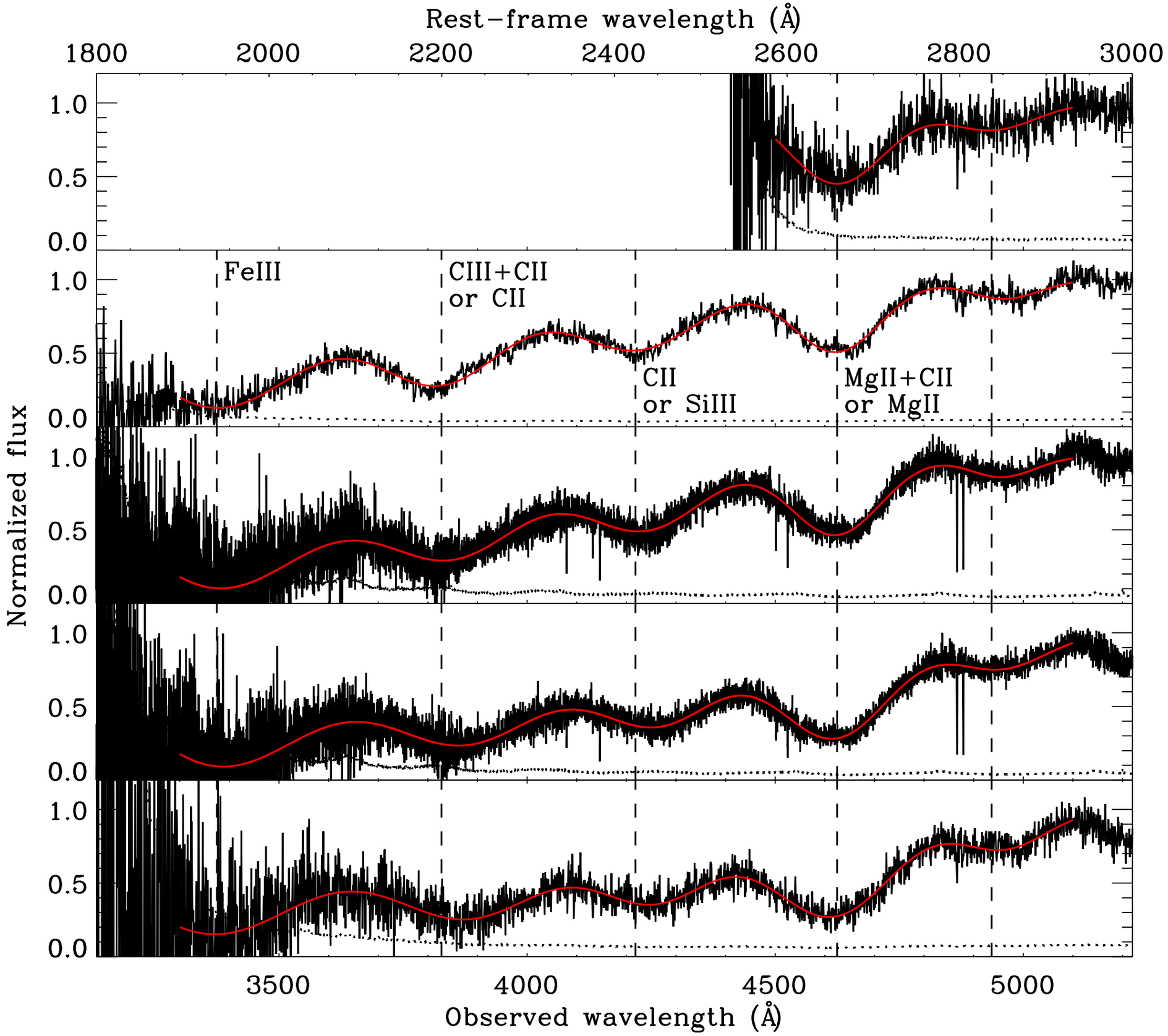


adapted from Quimby et al. (2011)

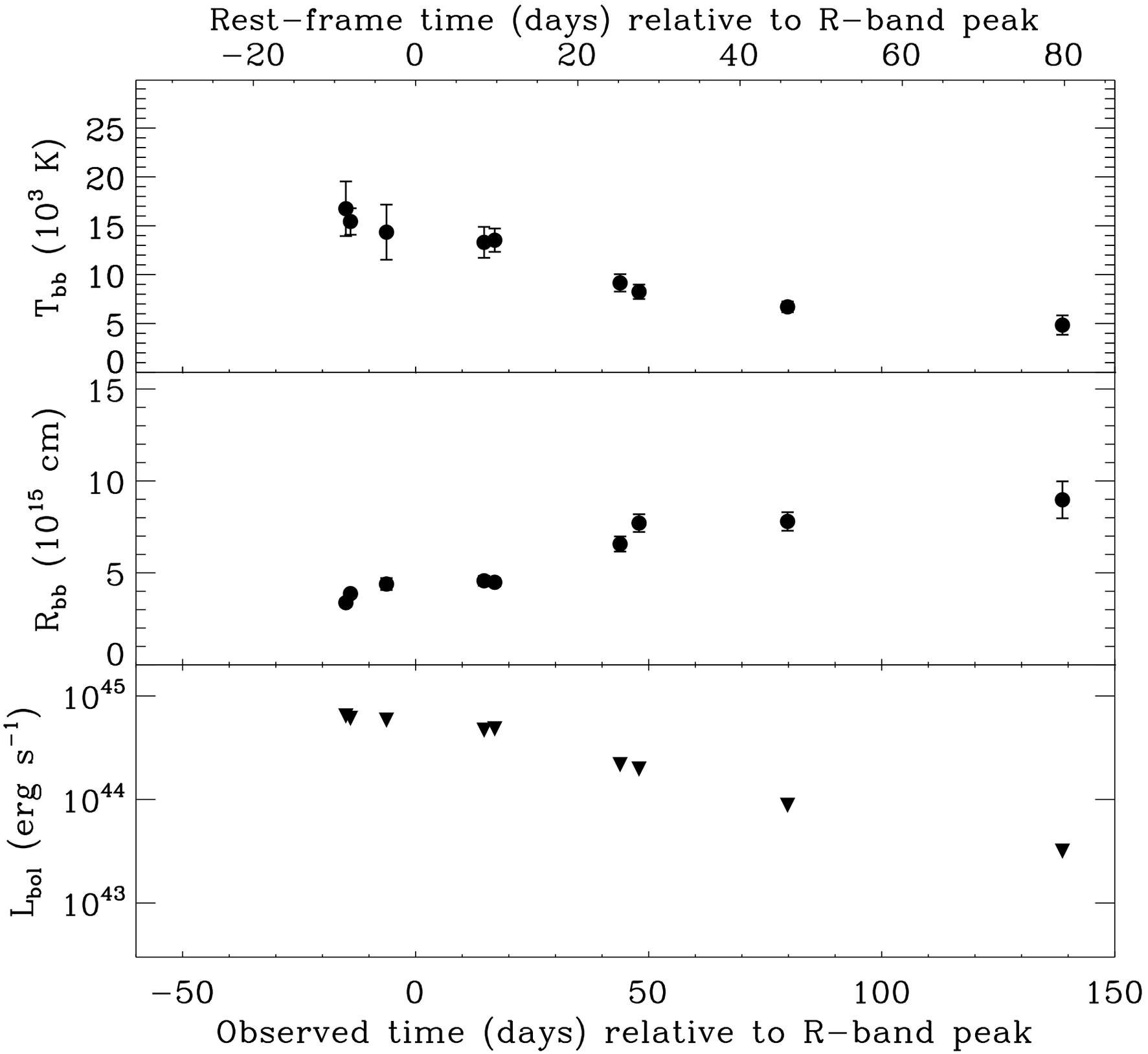
Keck/VLT spectra of iPTF13ajg



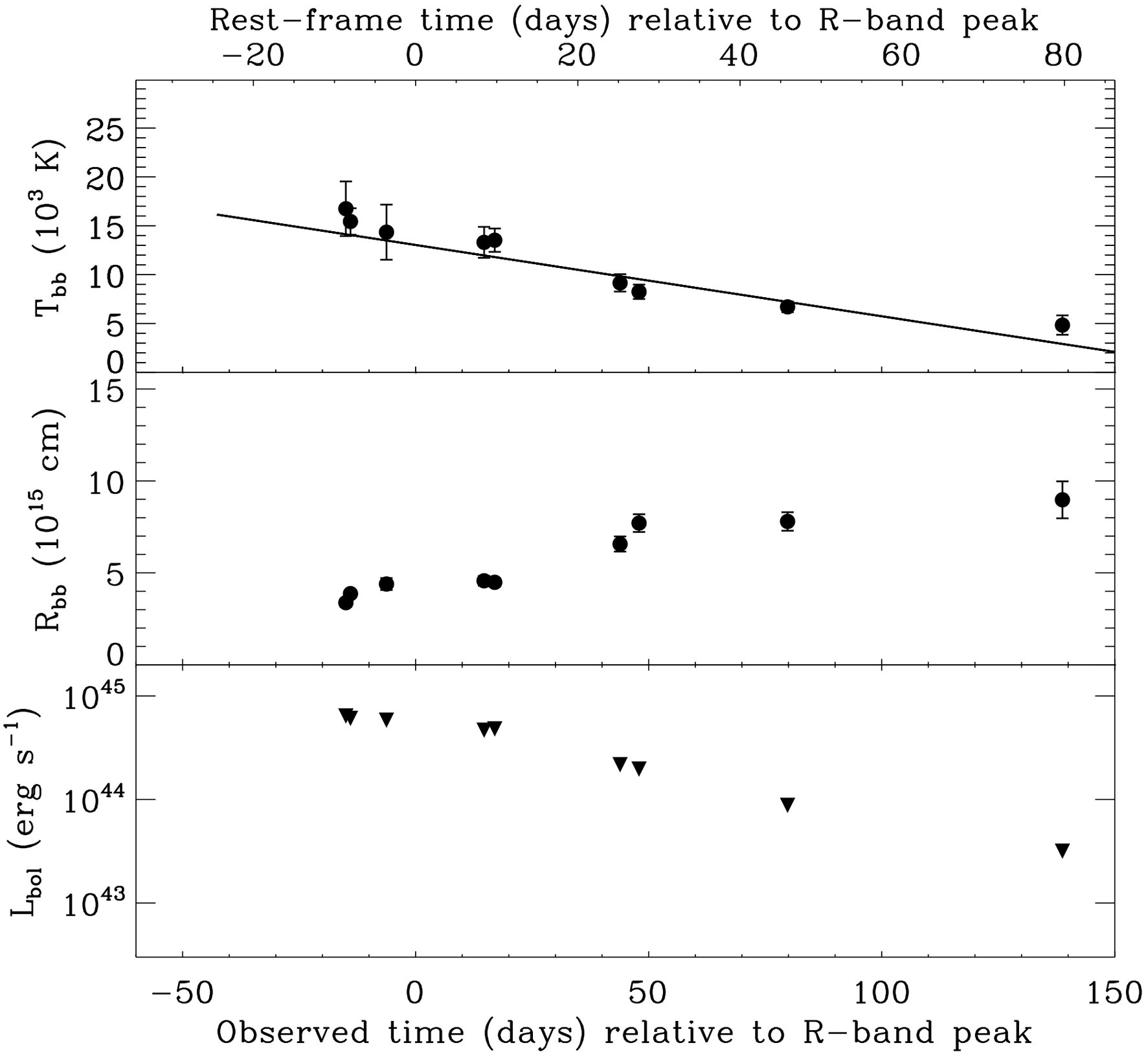
iPTF13ajg: broad UV absorption lines



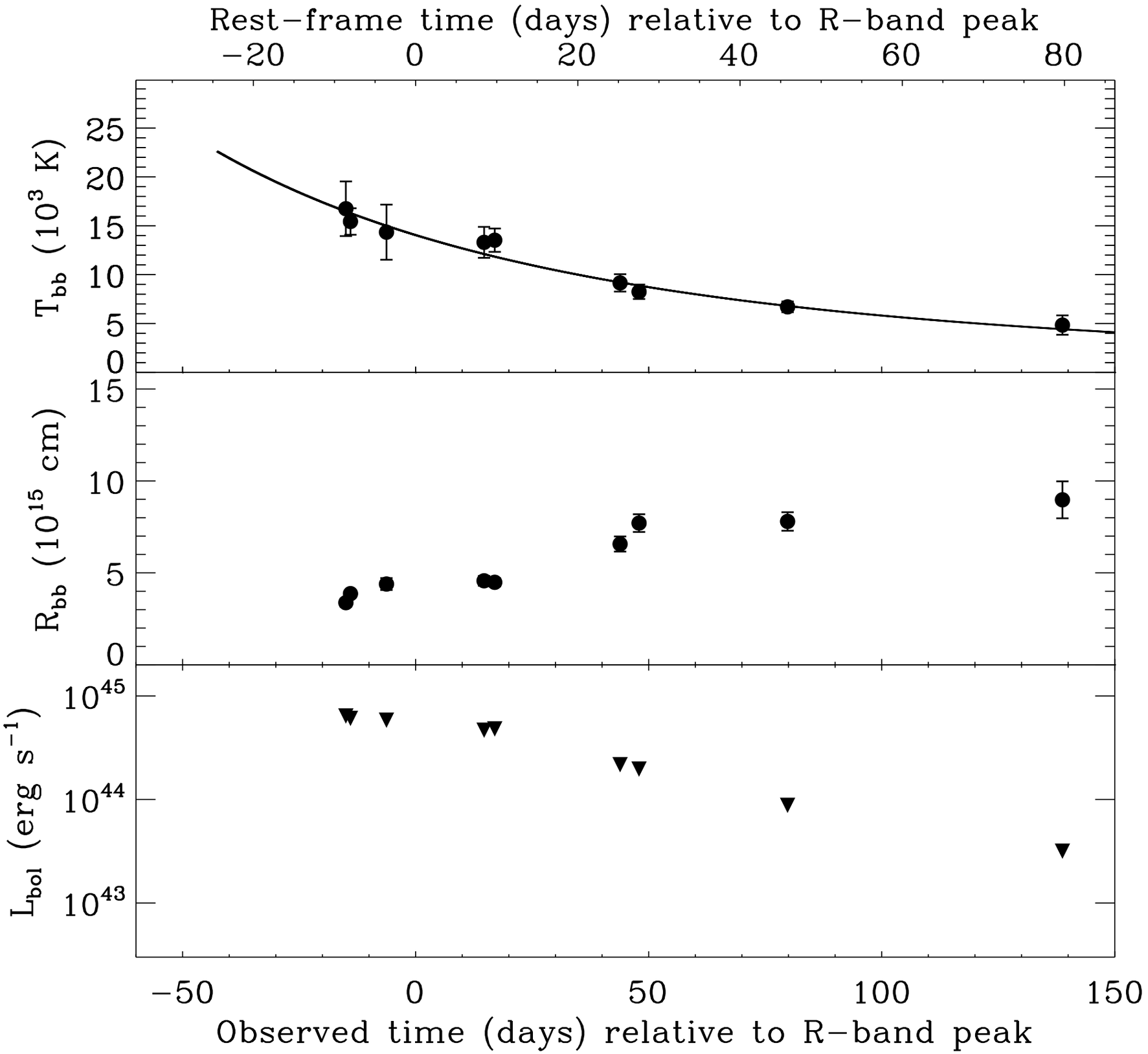
Bolometric light curve of iPTF13ajg



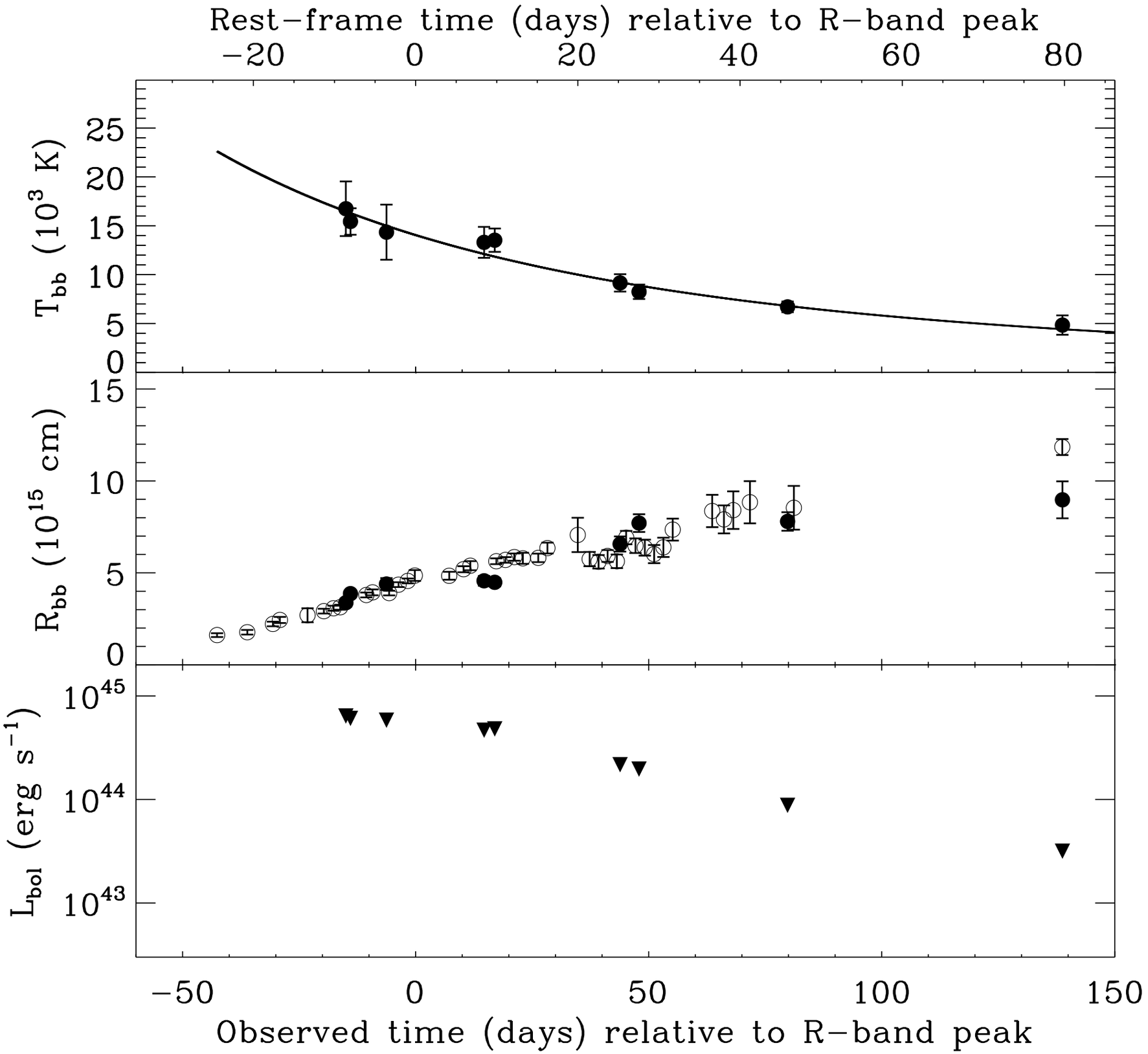
Bolometric light curve of iPTF13ajg



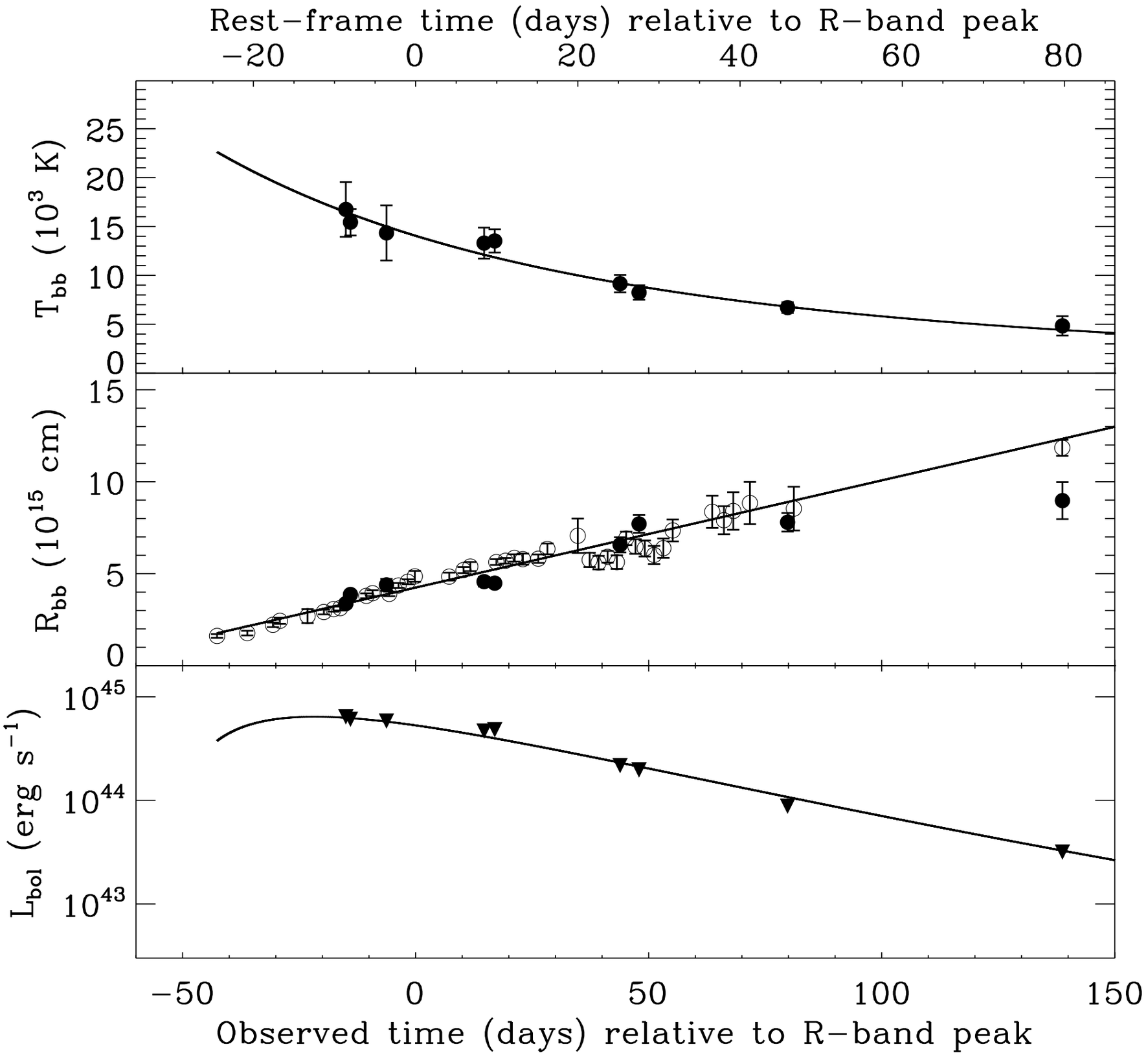
Bolometric light curve of iPTF13ajg



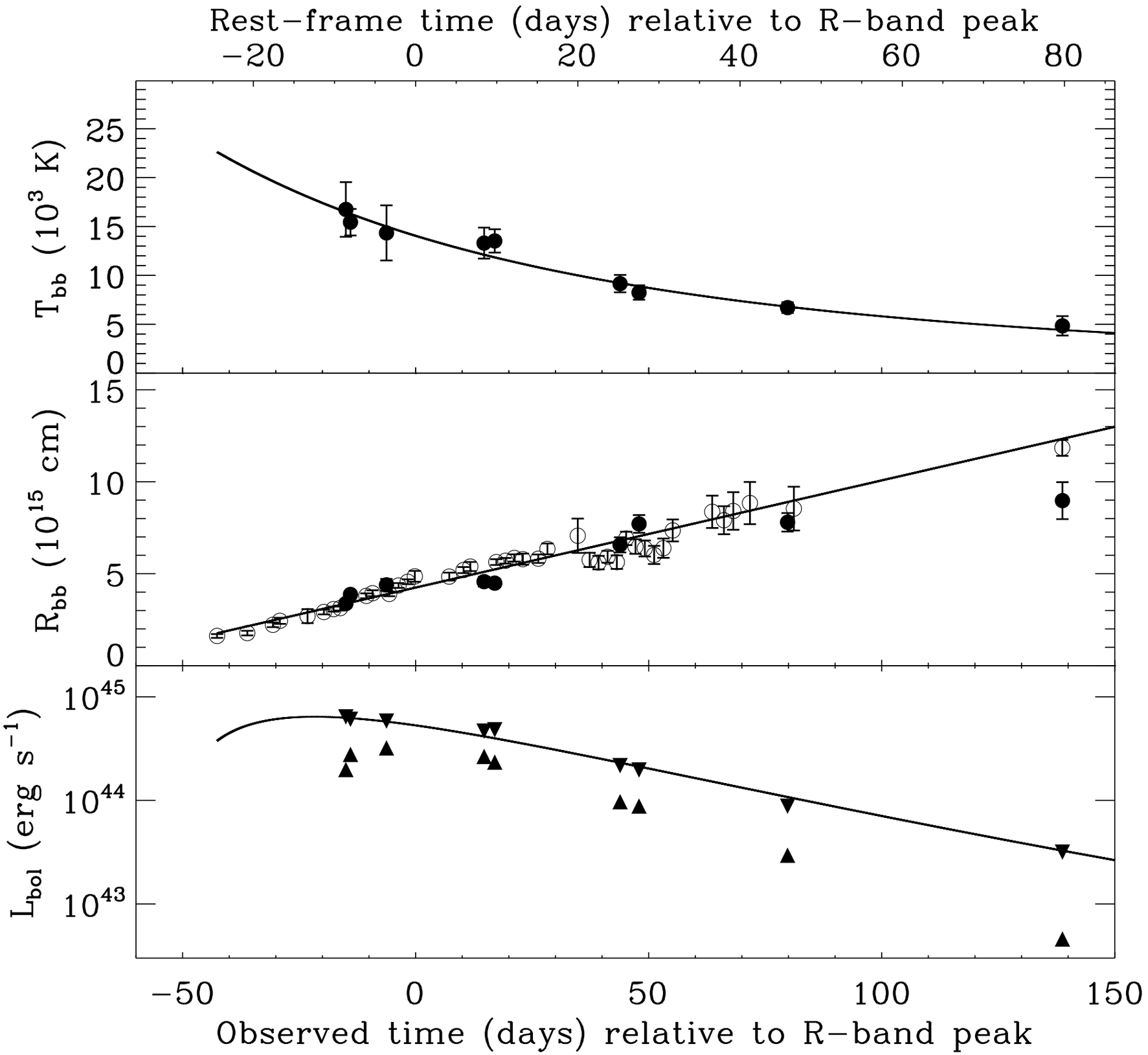
Bolometric light curve of iPTF13ajg



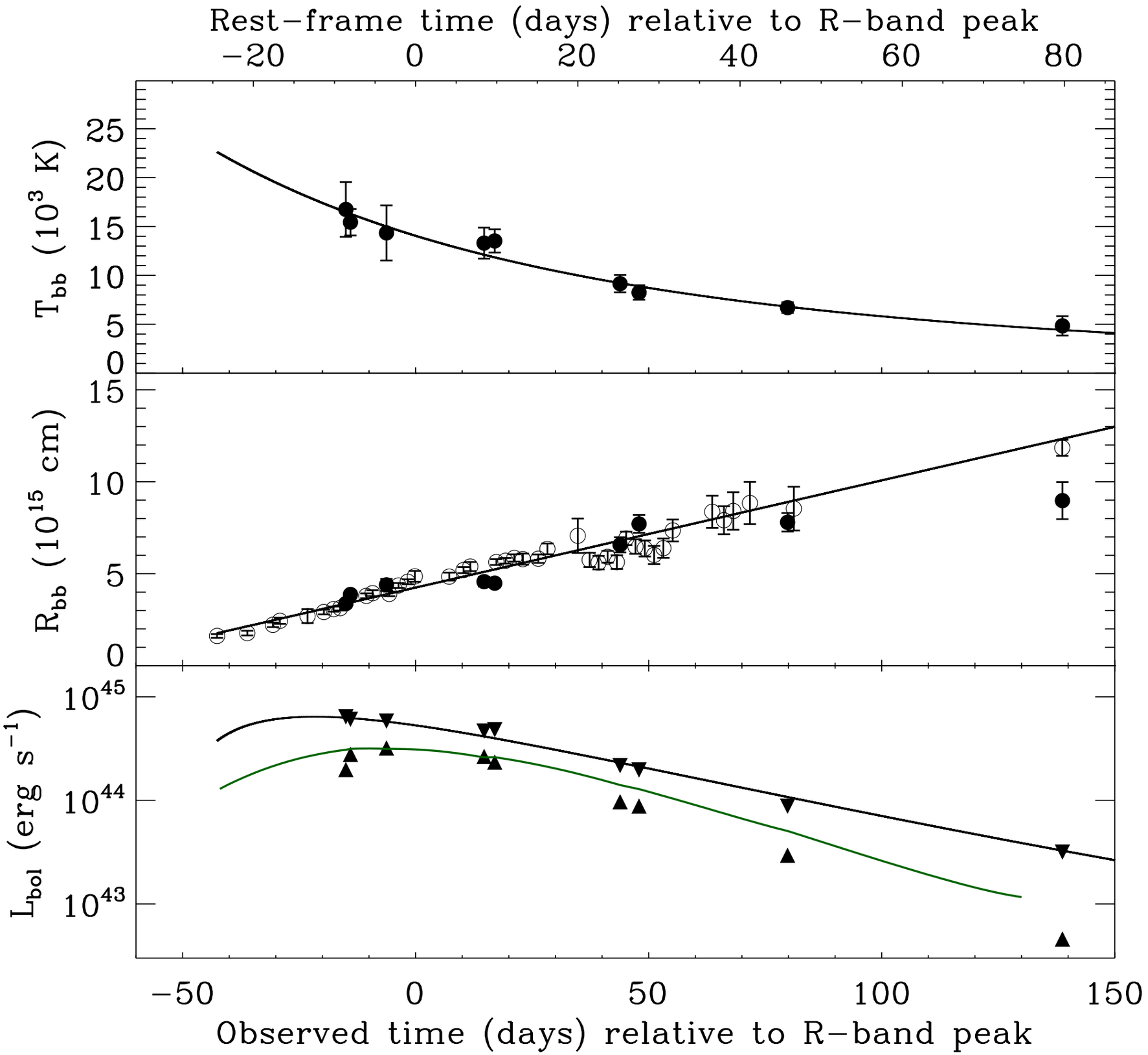
Bolometric light curve of iPTF13ajg



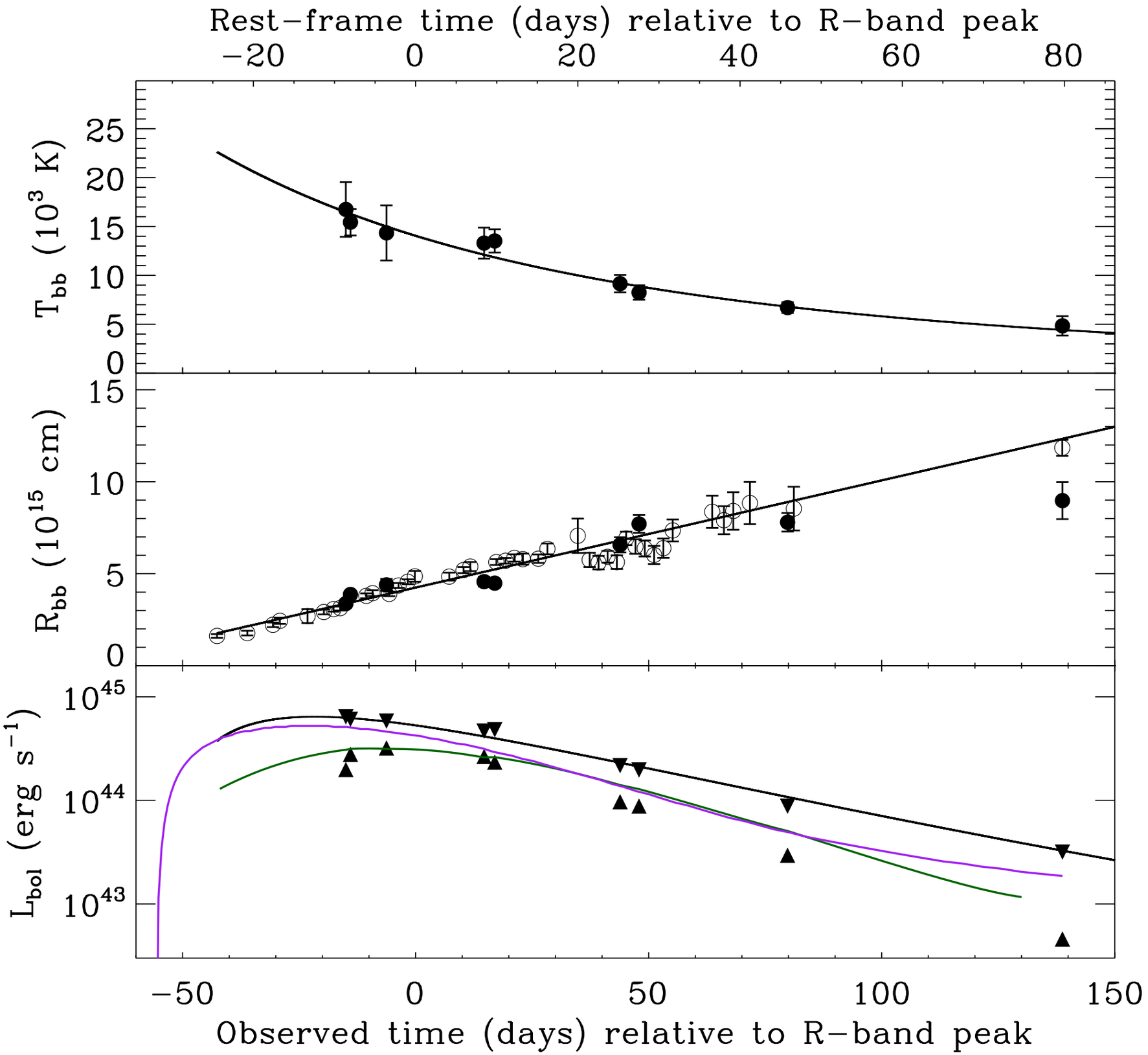
Bolometric light curve of iPTF13ajg



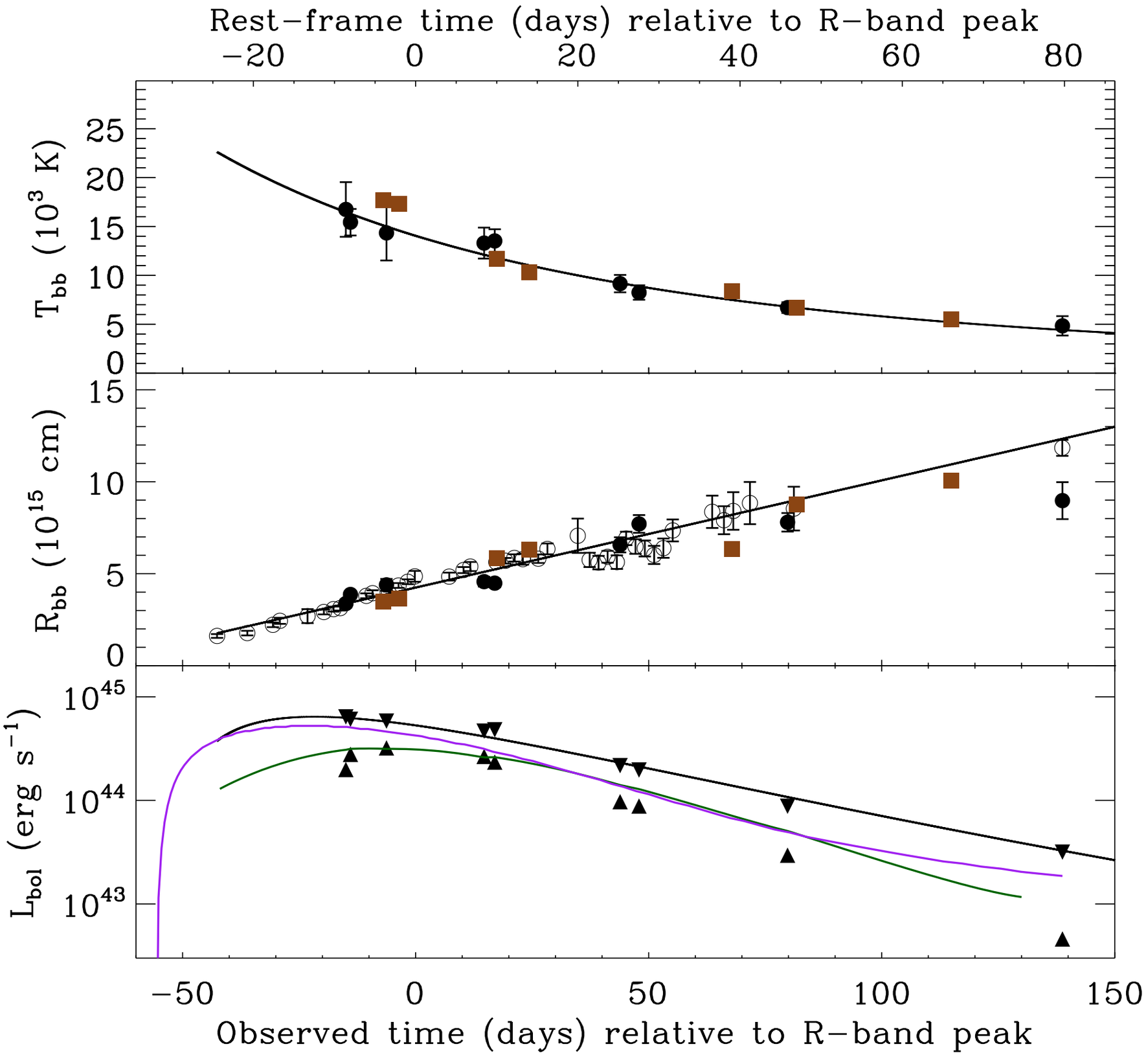
Bolometric light curve of iPTF13ajg



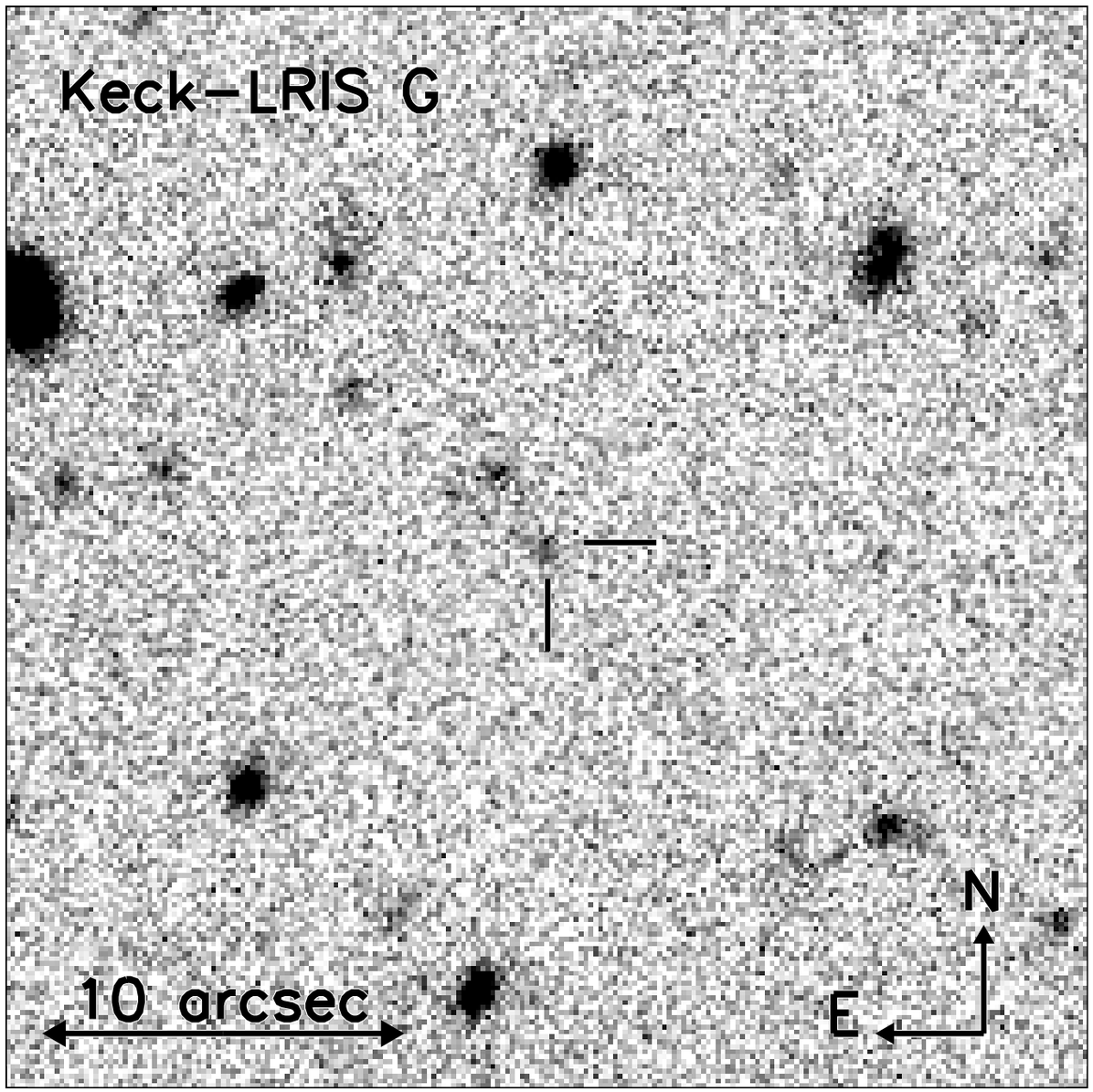
Bolometric light curve of iPTF13ajg

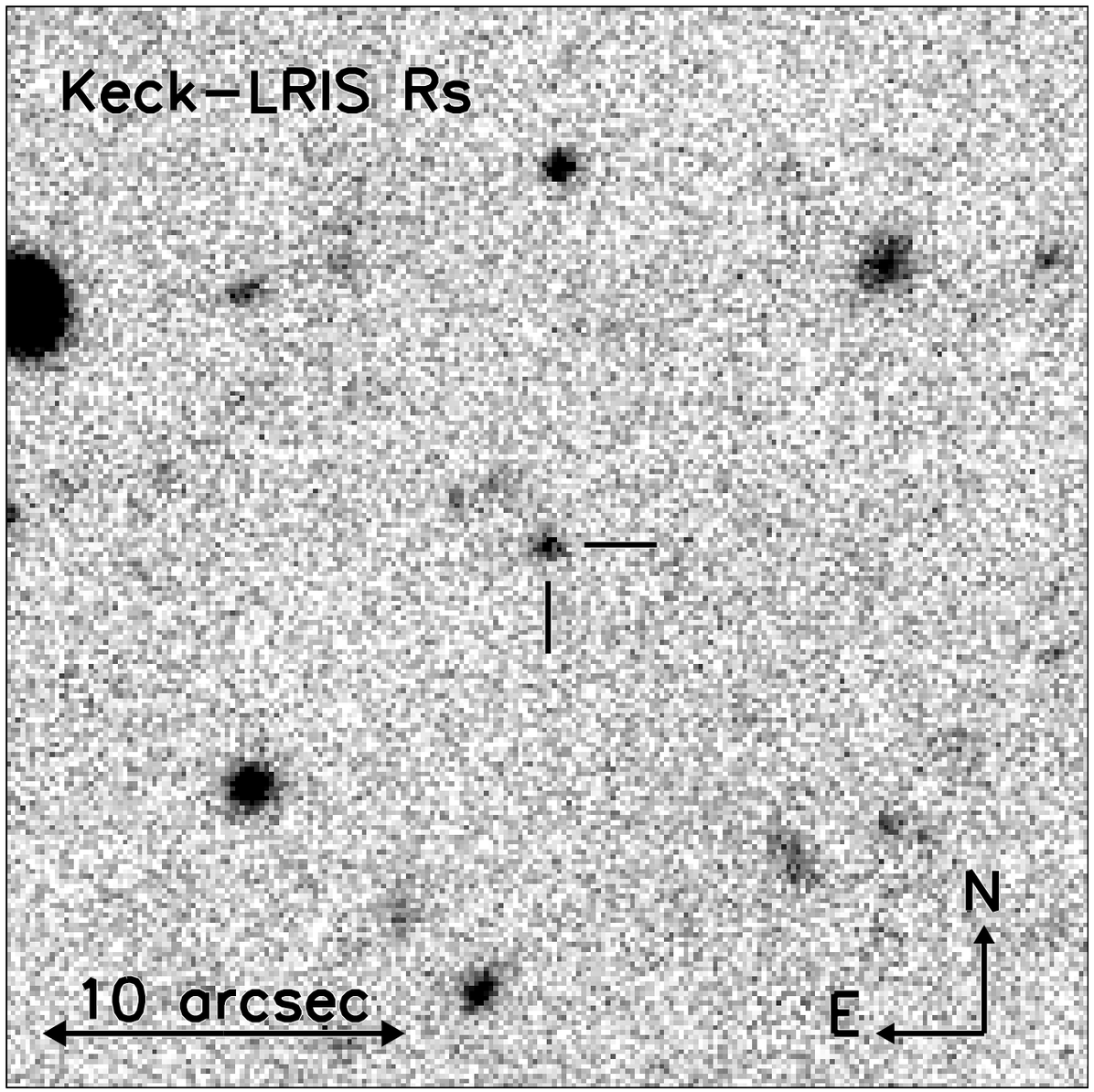


Bolometric light curve of iPTF13ajg



Keck/LRIS imaging of the host galaxy (April 201)

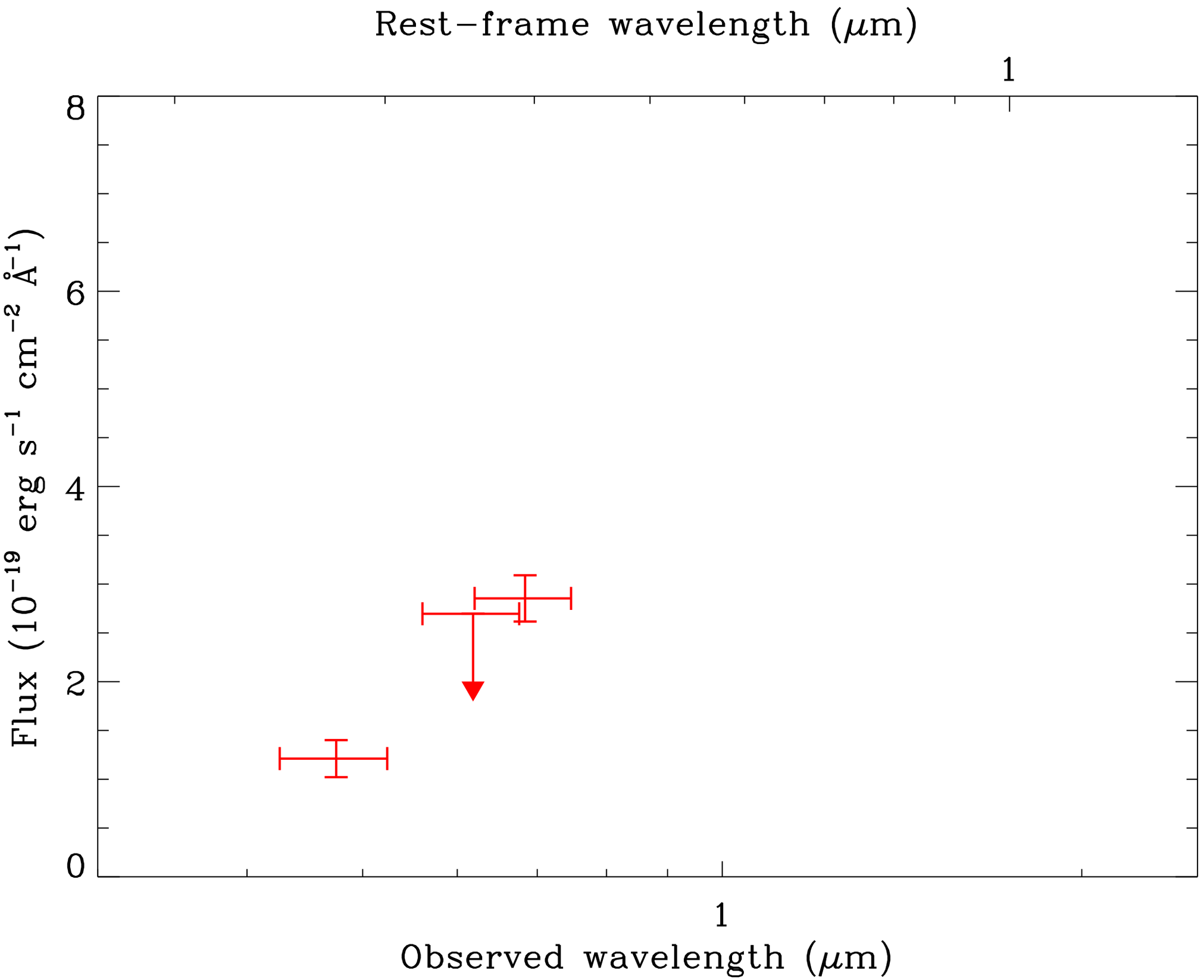




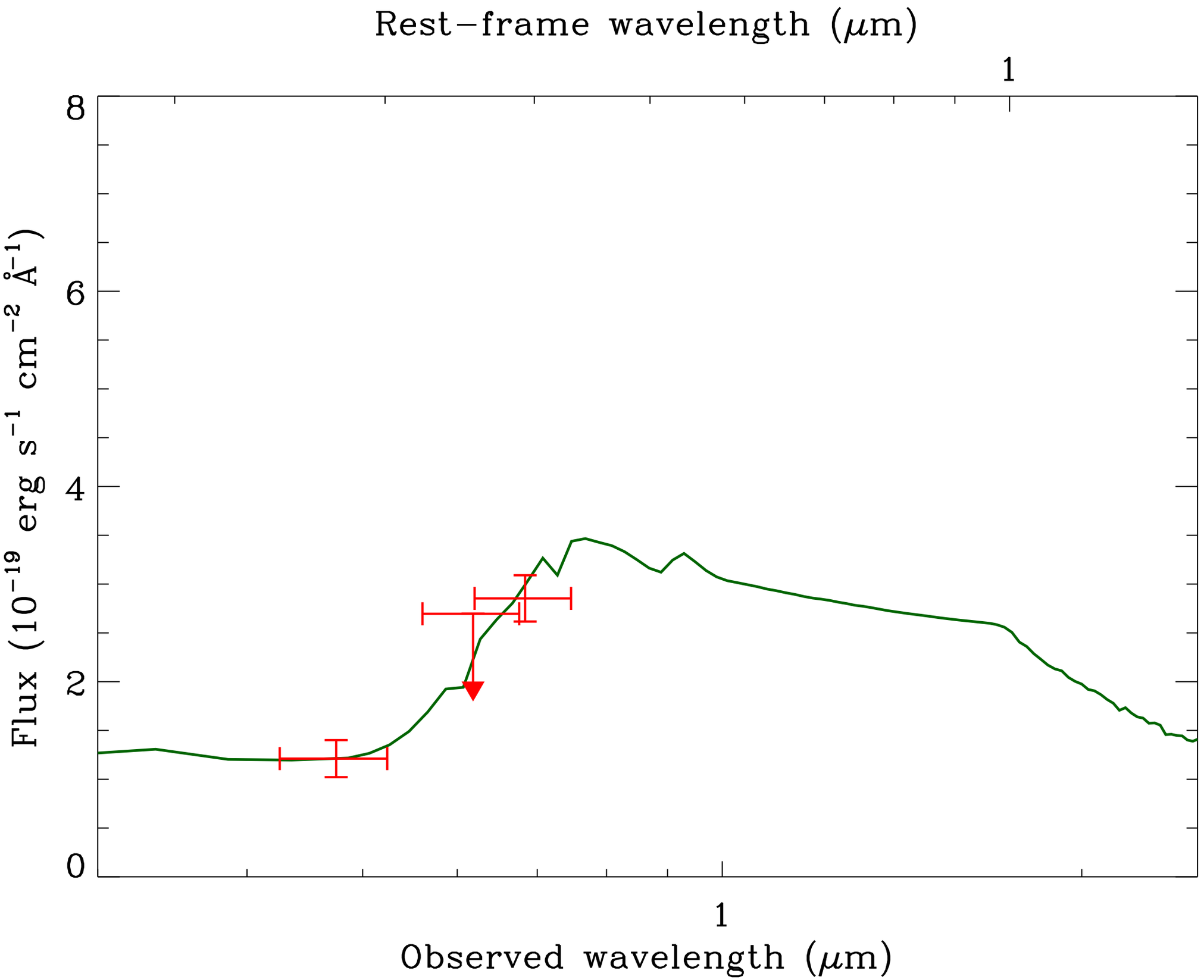
G = 26.57 ± 0.17

Rs=24.84 ± 0.09

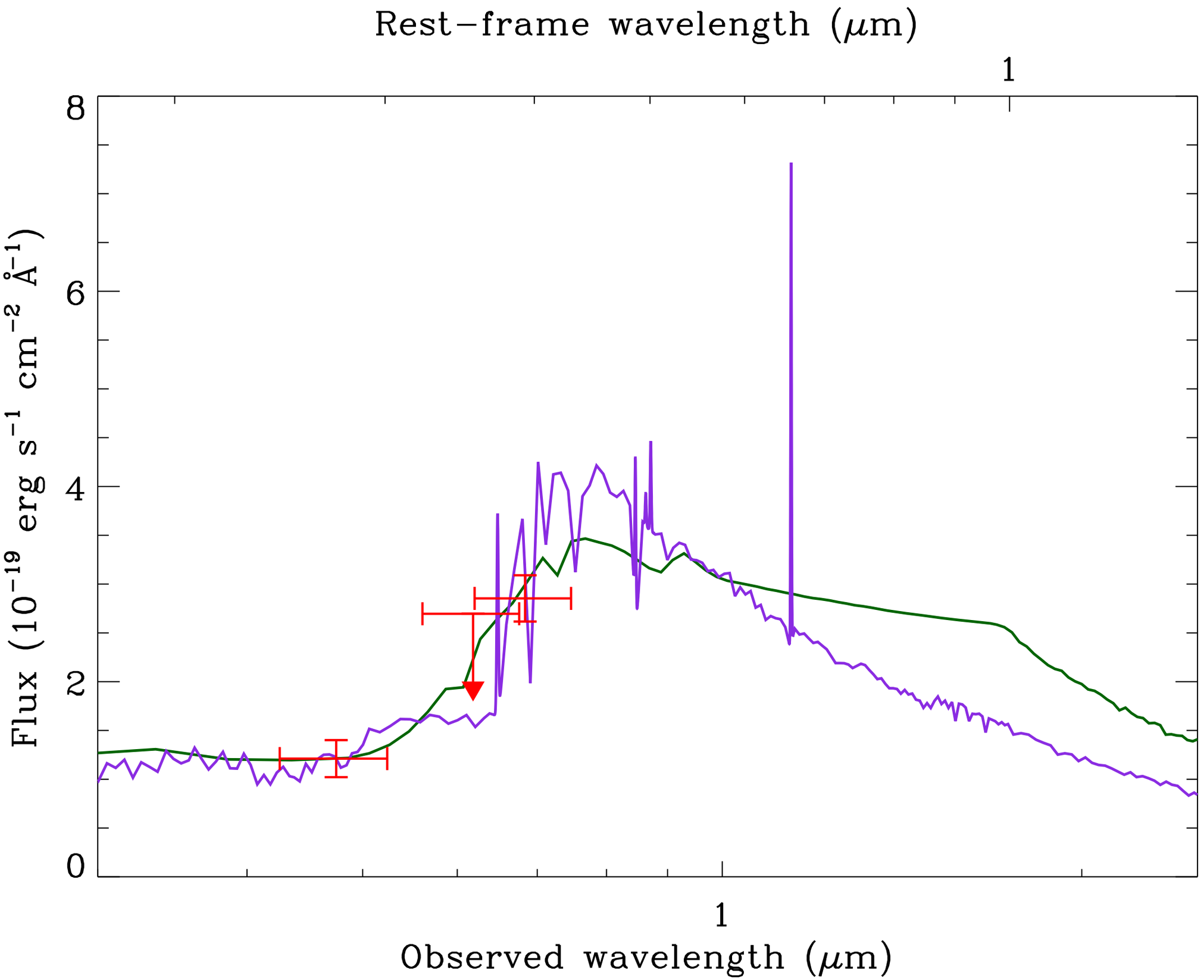
SED of iPTF13ajg host galaxy



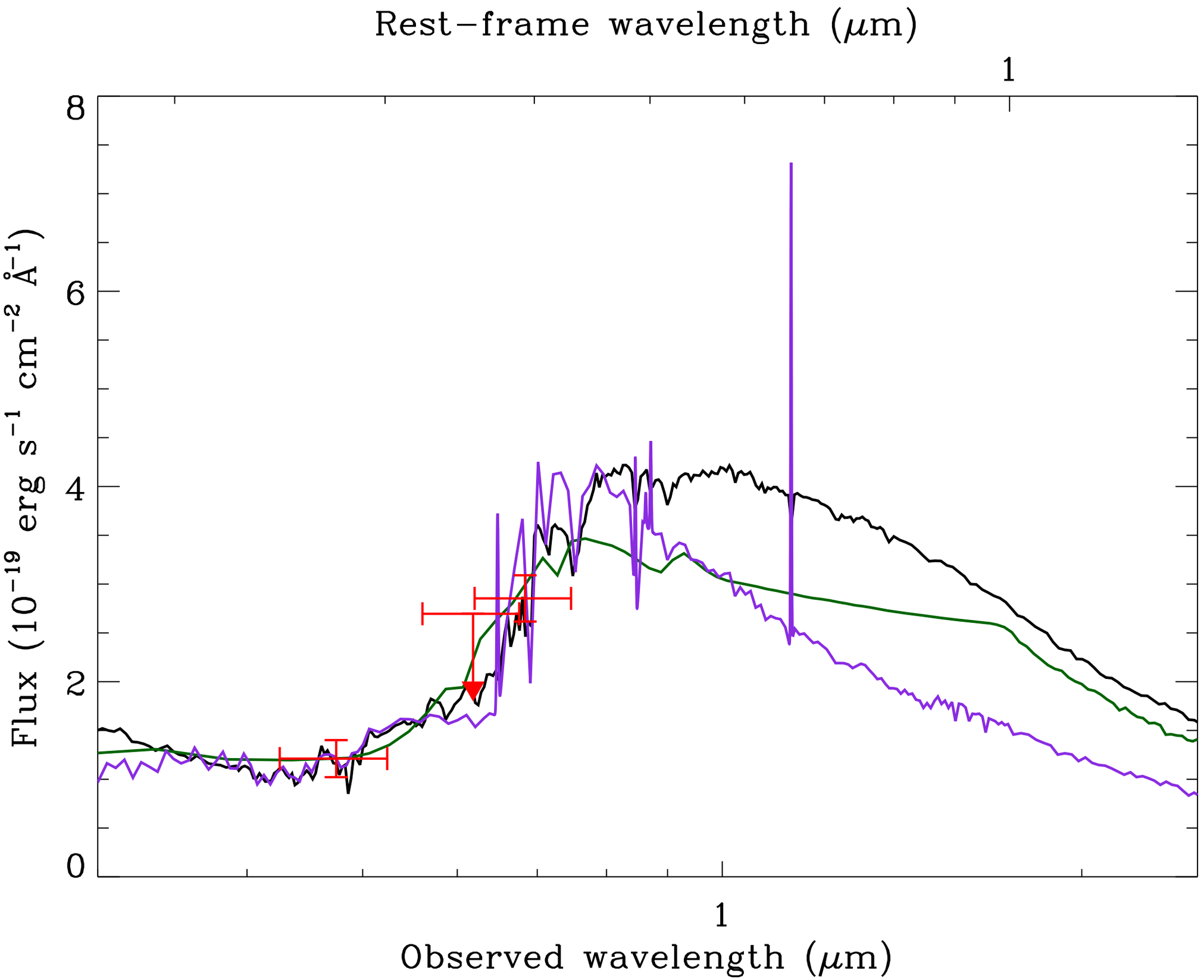
SED of iPTF13ajg host galaxy



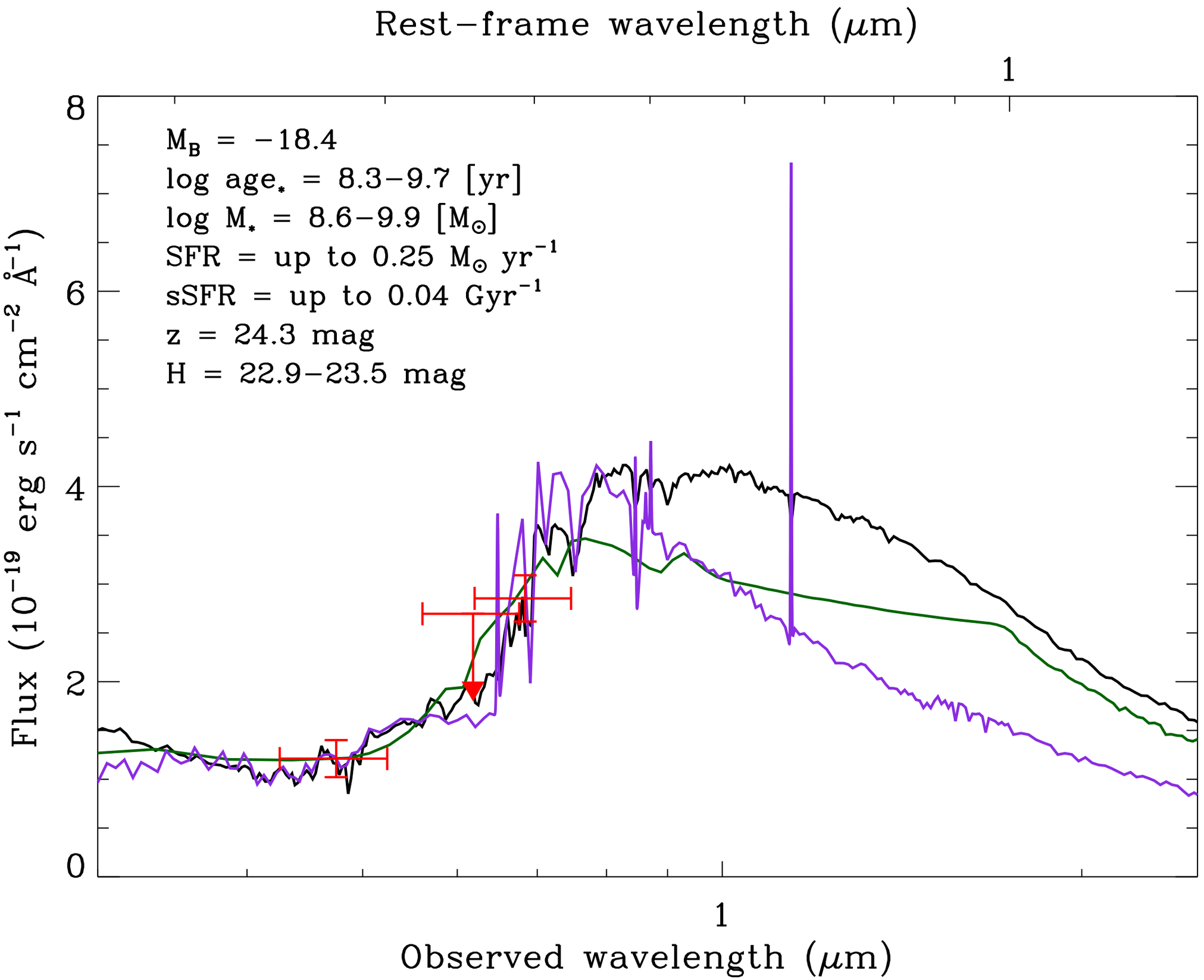
SED of iPTF13ajg host galaxy

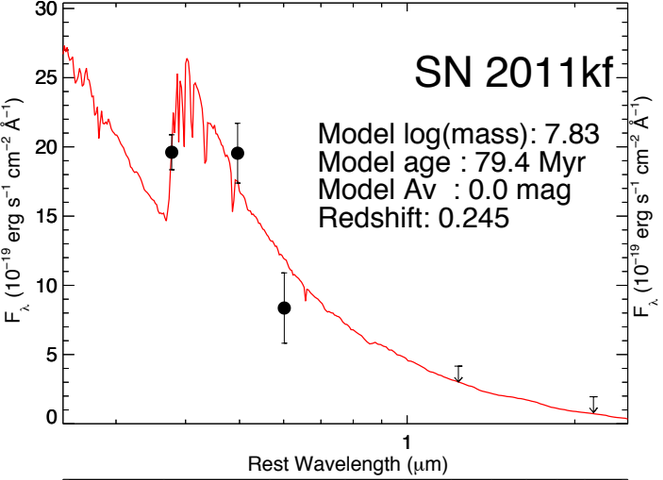


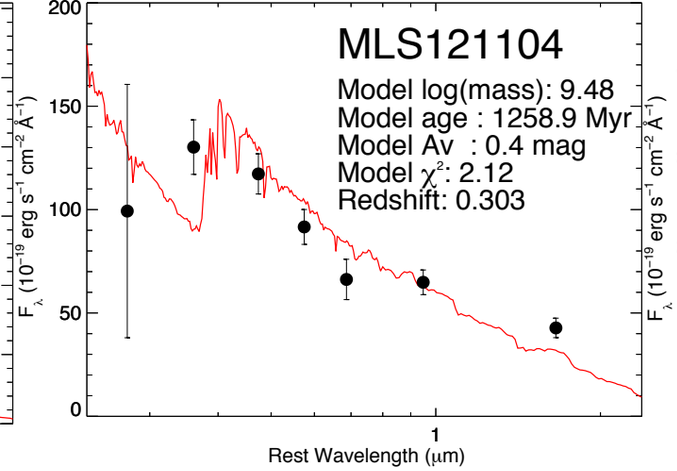
SED of iPTF13ajg host galaxy

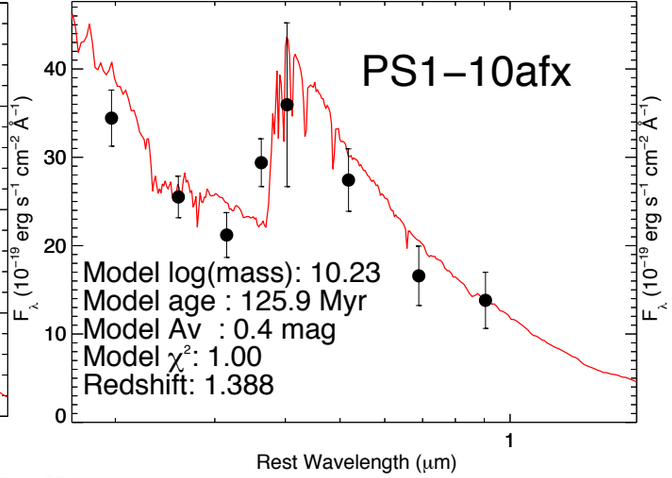


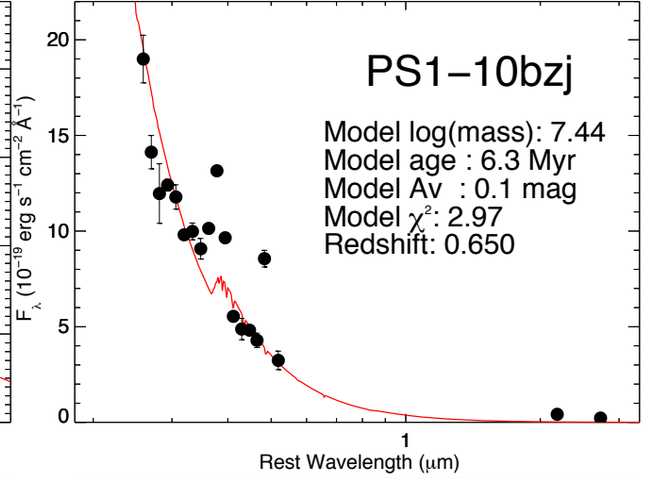
SED of iPTF13ajg host galaxy

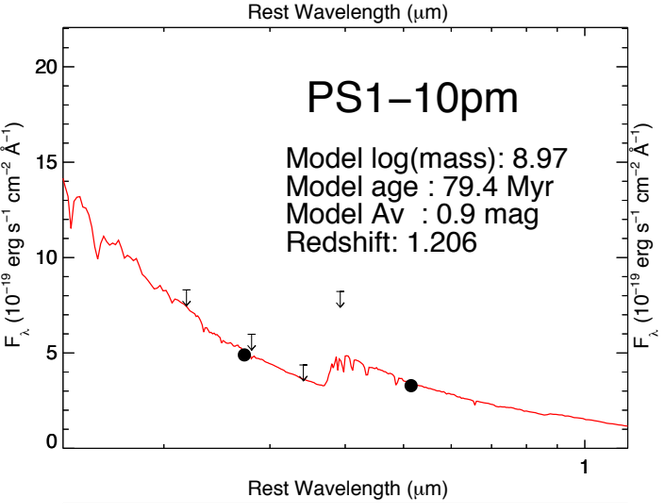


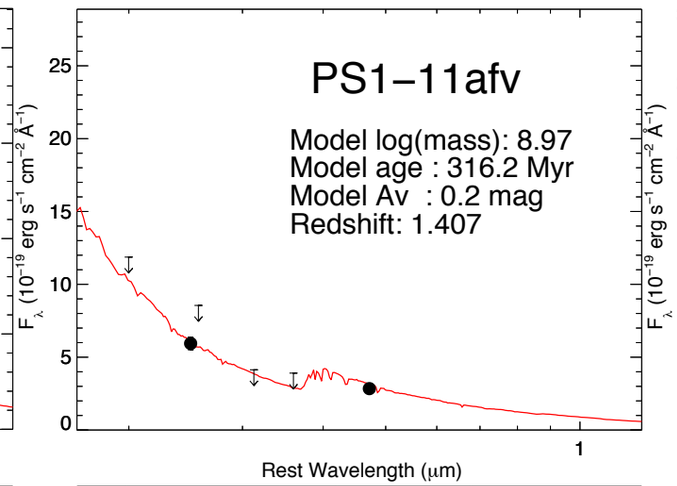

SN 2011kf
Model log(mass): 7.83
Model age : 79.4 Myr
Model Av : 0.0 mag
Redshift: 0.245

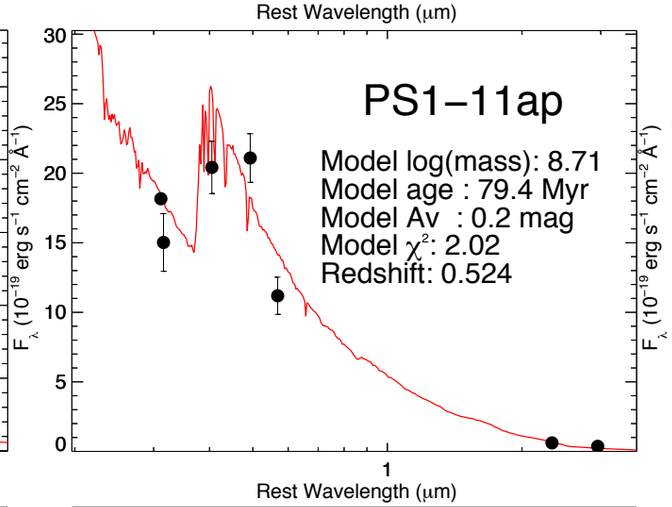

MLS121104
Model log(mass): 9.48
Model age : 1258.9 Myr
Model Av : 0.4 mag
Model χ²: 2.12
Redshift: 0.303

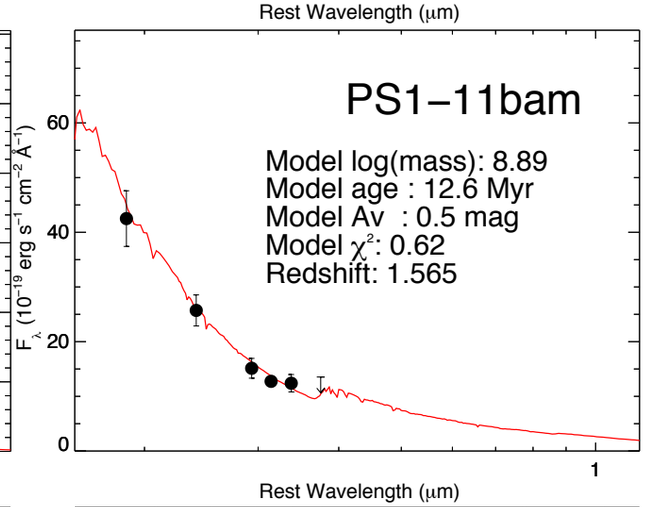

PS1−10afx
Model log(mass): 10.23
Model age : 125.9 Myr
Model Av : 0.4 mag
Model χ²: 1.00
Redshift: 1.388

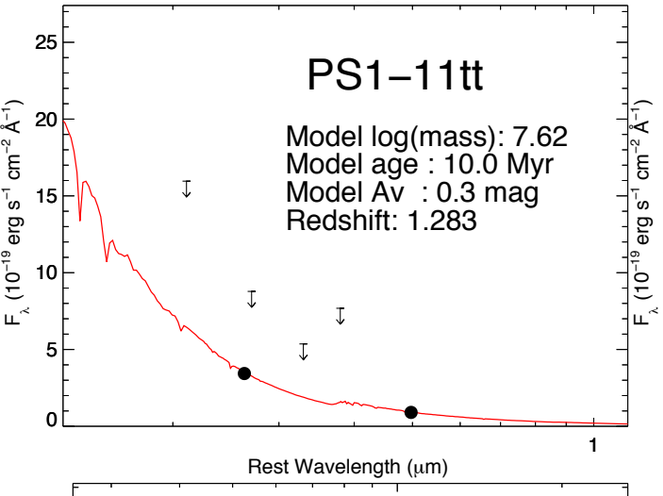

PS1−10bzj
Model log(mass): 7.44
Model age : 6.3 Myr
Model Av : 0.1 mag
Model χ²: 2.97
Redshift: 0.650

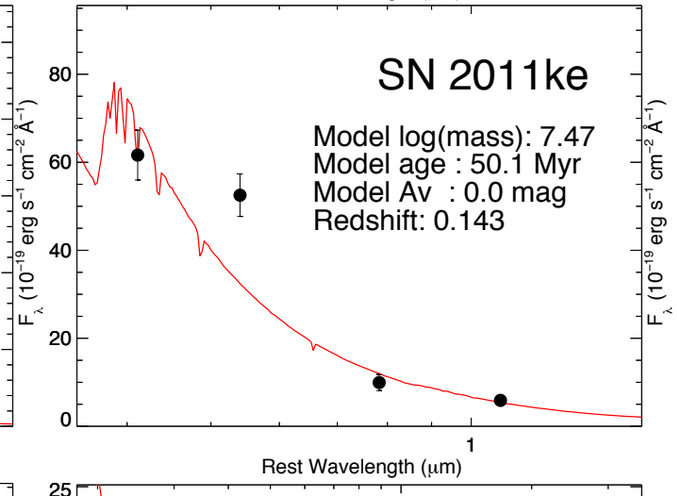

PS1−10pm
Model log(mass): 8.97
Model age : 79.4 Myr
Model Av : 0.9 mag
Redshift: 1.206

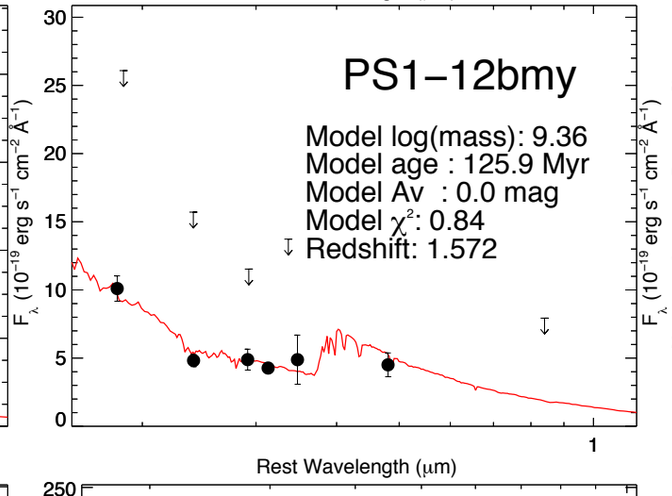

PS1−11afv
Model log(mass): 8.97
Model age : 316.2 Myr
Model Av : 0.2 mag
Redshift: 1.407

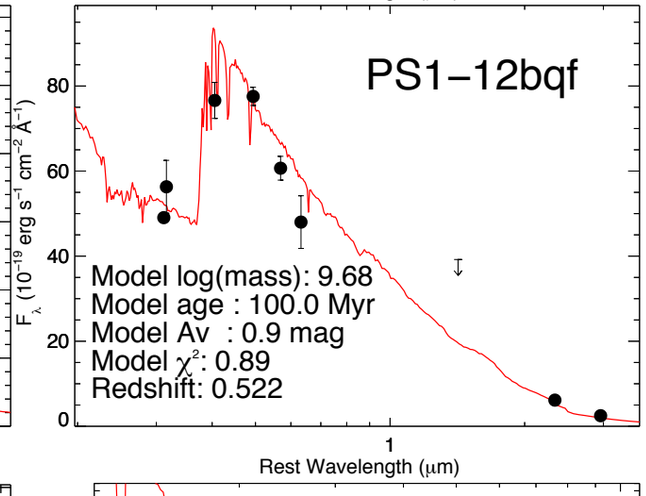

PS1−11ap
Model log(mass): 8.71
Model age : 79.4 Myr
Model Av : 0.2 mag
Model χ²: 2.02
Redshift: 0.524

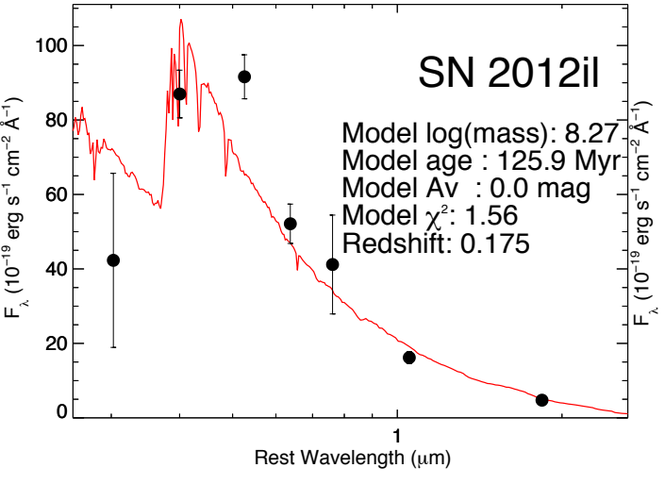

PS1−11bam
Model log(mass): 8.89
Model age : 12.6 Myr
Model Av : 0.5 mag
Model χ²: 0.62
Redshift: 1.565

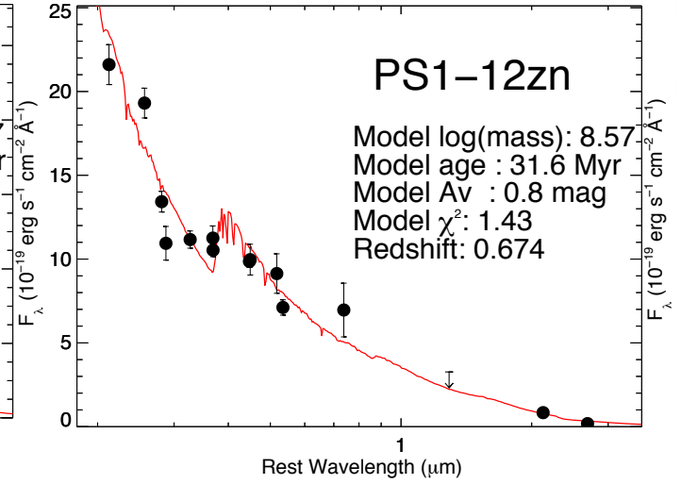

PS1−11tt
Model log(mass): 7.62
Model age : 10.0 Myr
Model Av : 0.3 mag
Redshift: 1.283

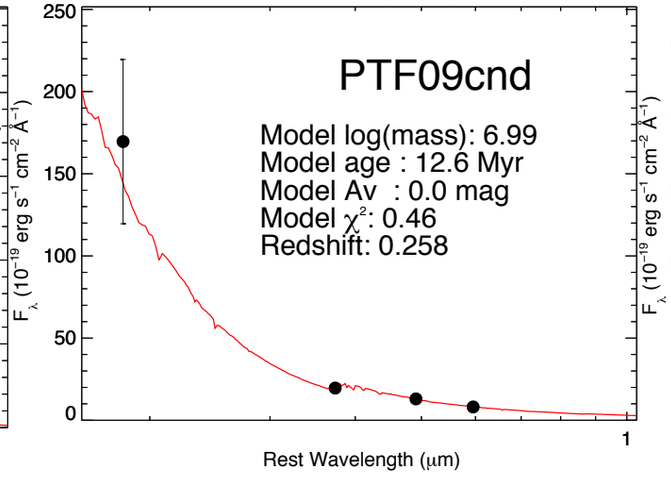

SN 2011ke
Model log(mass): 7.47
Model age : 50.1 Myr
Model Av : 0.0 mag
Redshift: 0.143

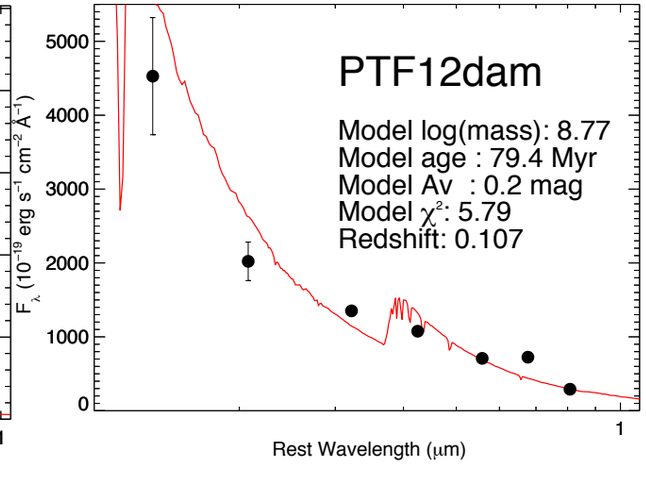

PS1−12bmy
Model log(mass): 9.36
Model age : 125.9 Myr
Model Av : 0.0 mag
Model χ²: 0.84
Redshift: 1.572


PS1−12bqf
Model log(mass): 9.68
Model age : 100.0 Myr
Model Av : 0.9 mag
Model χ²: 0.89
Redshift: 0.522

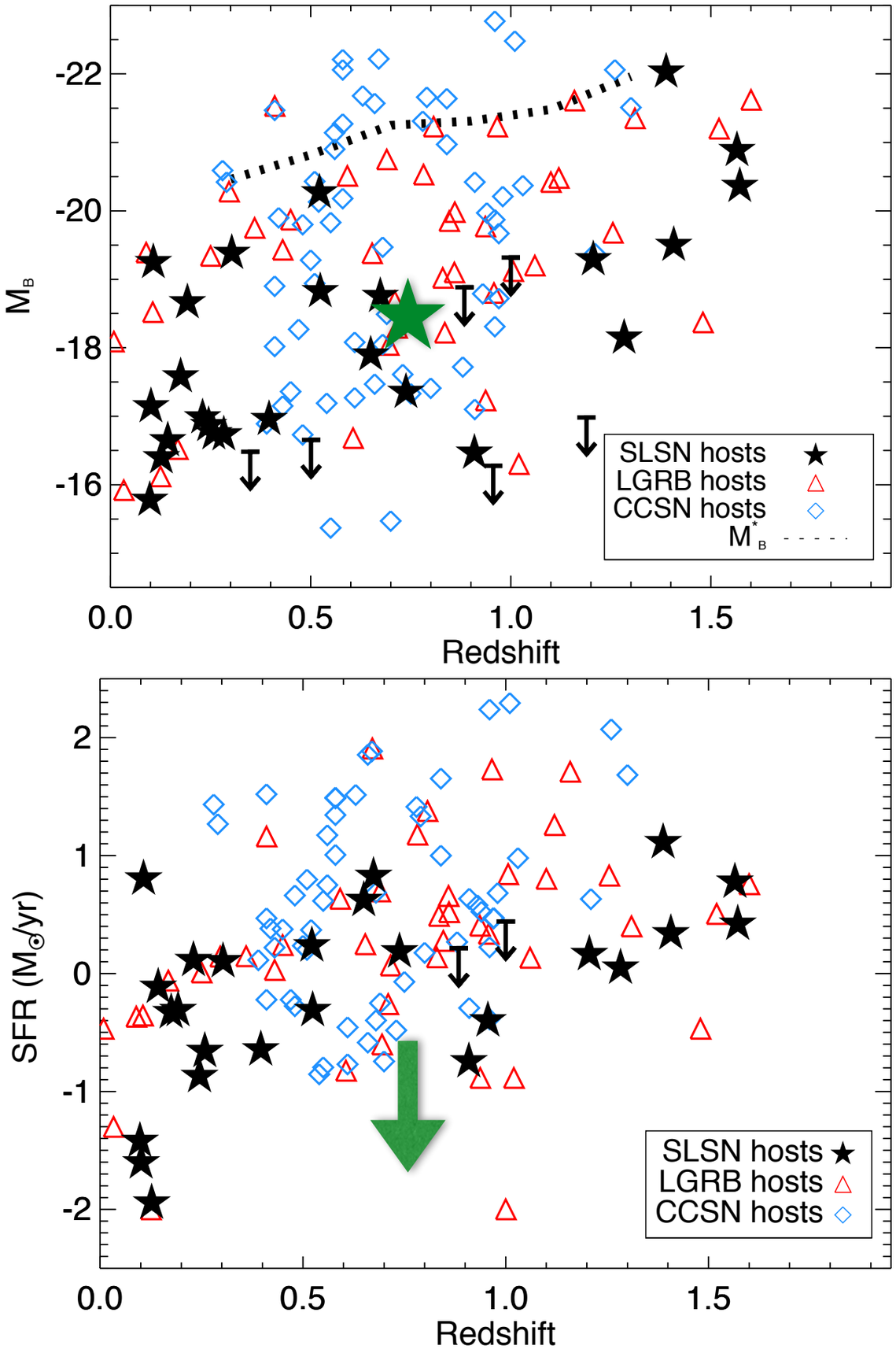

SN 2012il
Model log(mass): 8.27
Model age : 125.9 Myr
Model Av : 0.0 mag
Model χ²: 1.56
Redshift: 0.175

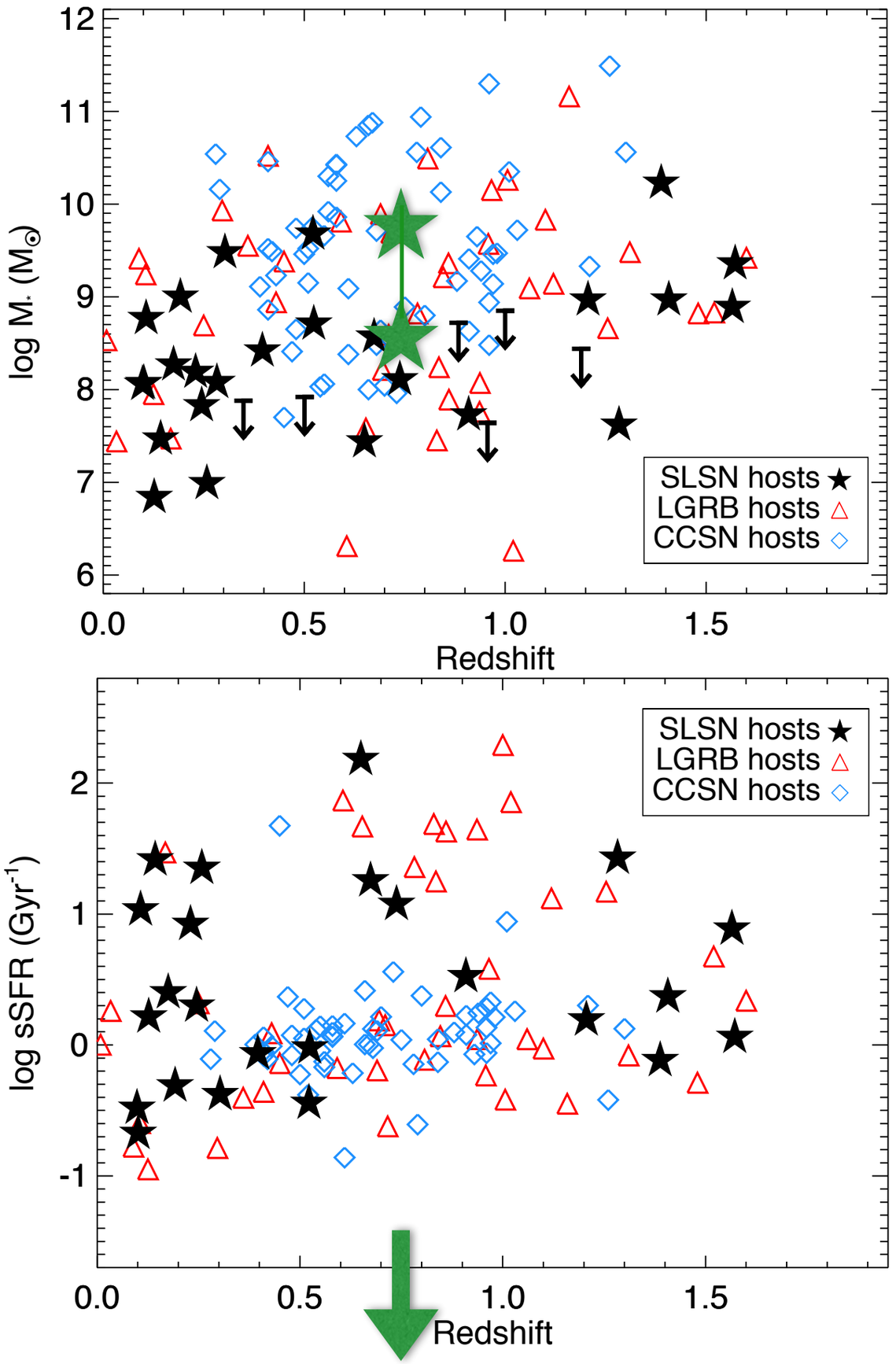

PS1−12zn
Model log(mass): 8.57
Model age : 31.6 Myr
Model Av : 0.8 mag
Model χ²: 1.43
Redshift: 0.674


PTF09cnd
Model log(mass): 6.99
Model age : 12.6 Myr
Model Av : 0.0 mag
Model χ²: 0.46
Redshift: 0.258

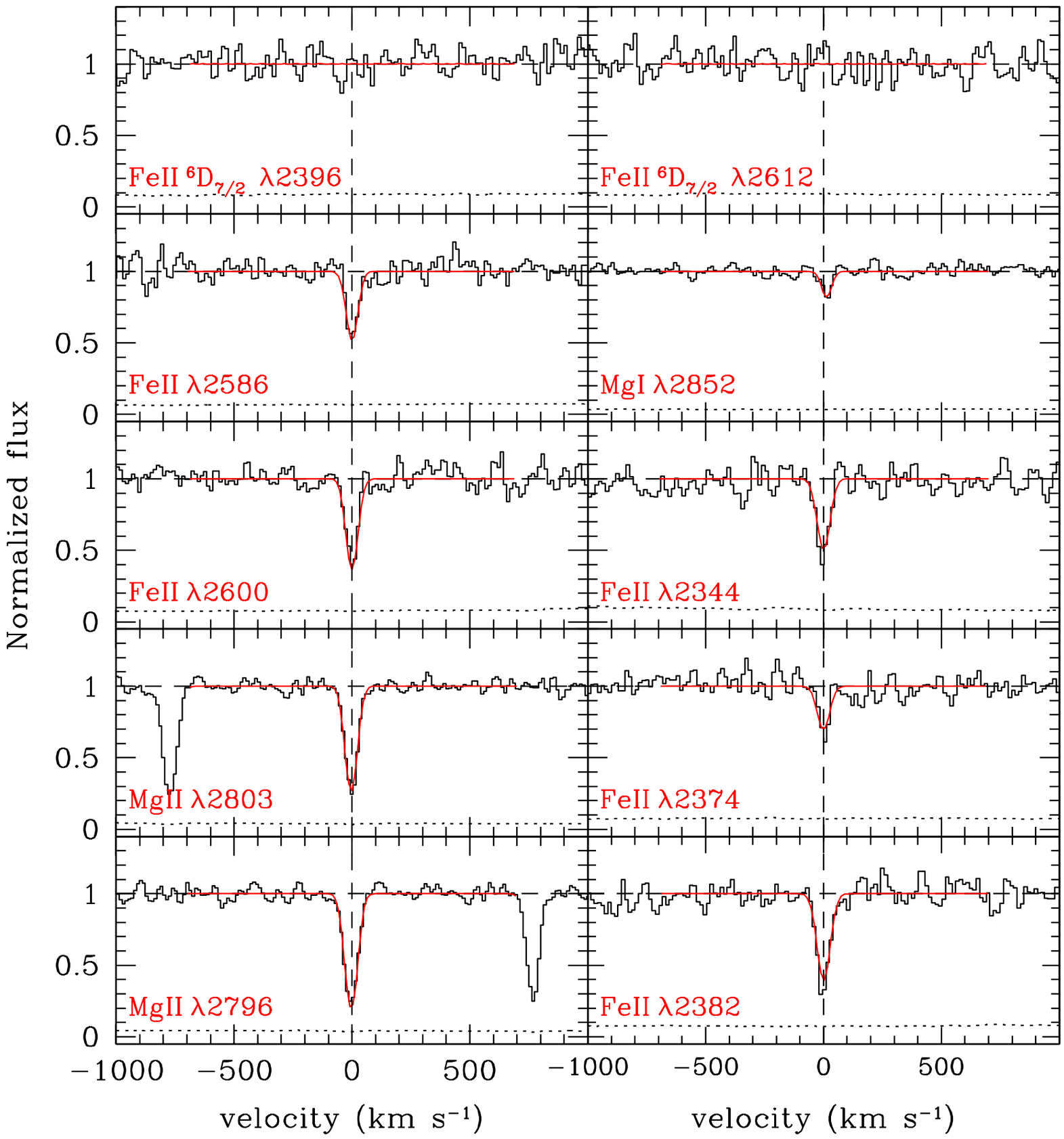

PTF12dam
Model log(mass): 8.77
Model age : 79.4 Myr
Model Av : 0.2 mag
Model χ²: 5.79
Redshift: 0.107

iPTF13ajg: comparison with Lunnan et al.



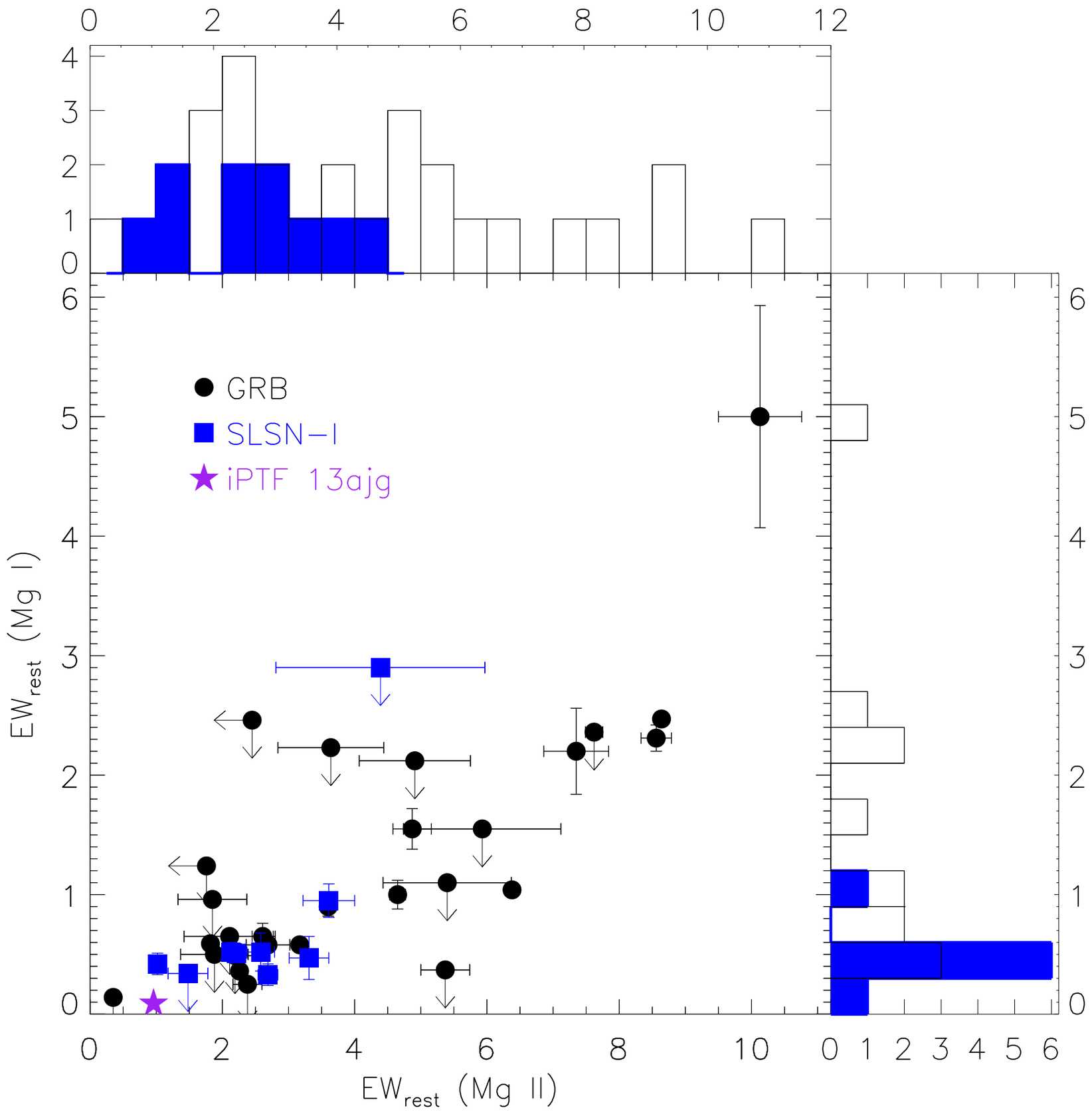


iPTF13ajg: narrow UV absorption lines

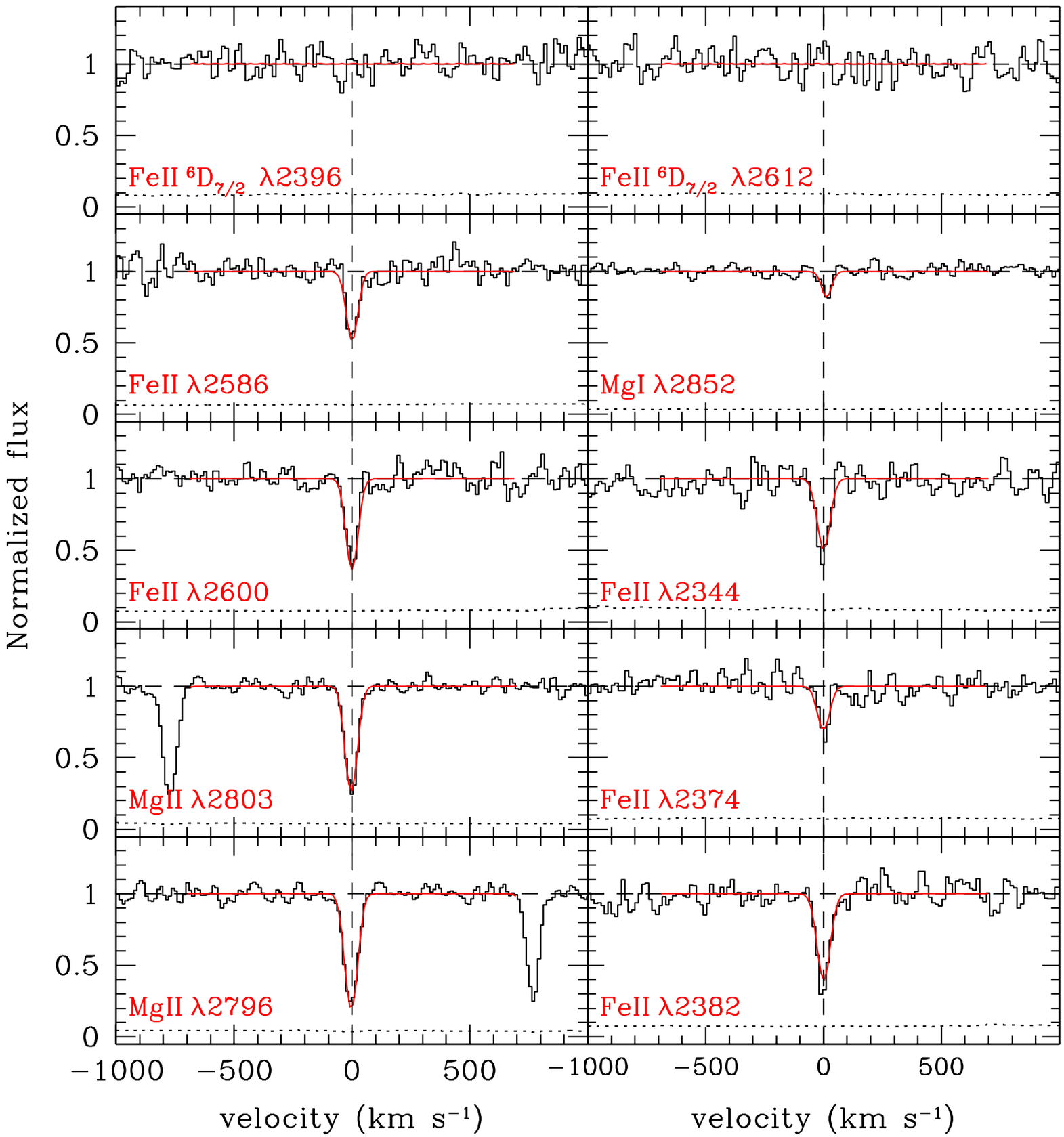


- single narrow component
- log N (Mg I) = 11.9
- log N (Mg II) =14.7
- log N (Fe II) = 14.3

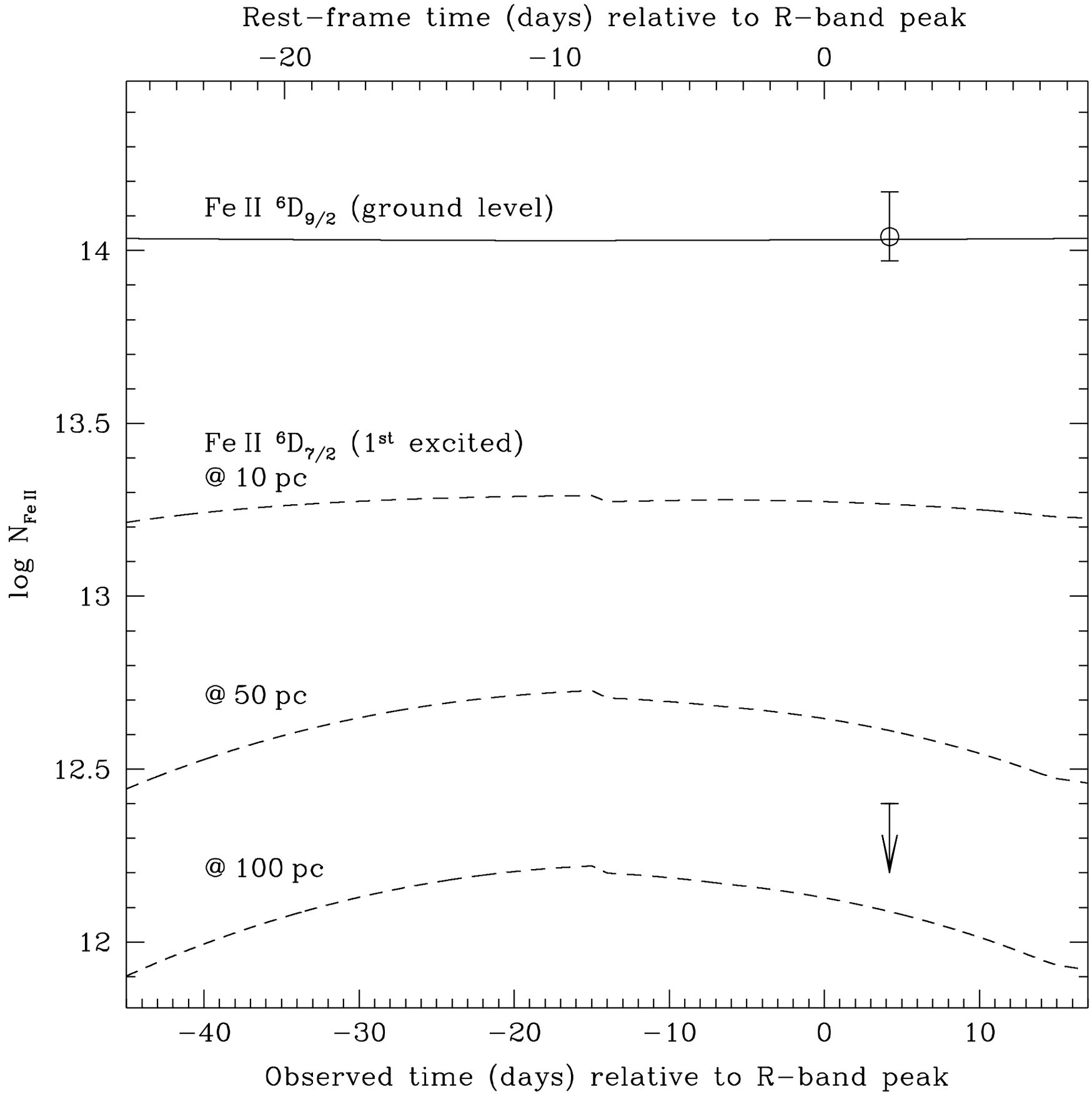
Mg I and Mg II strength in GRBs and iPTF SLSNe



iPTF13ajg: narrow UV absorption lines



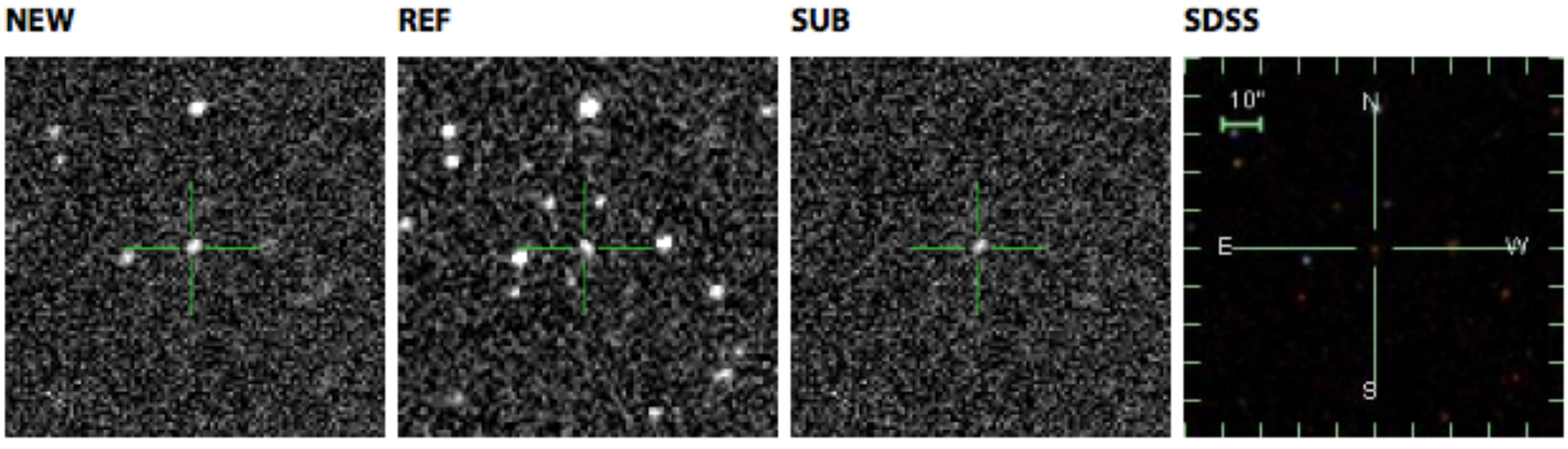
- no Fe II or Ni II fine-structure lines detected

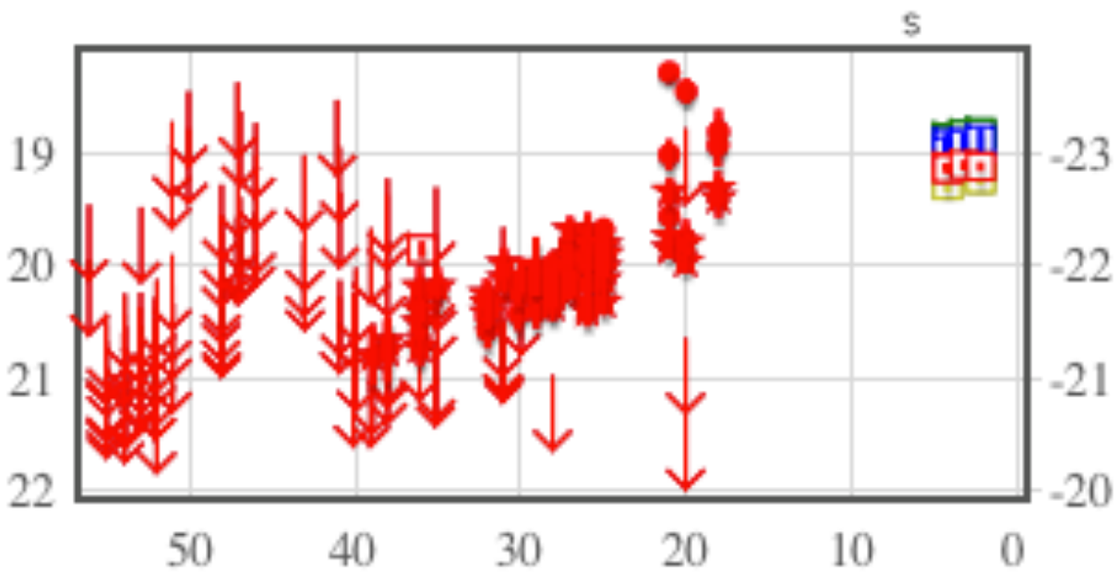

Rest−frame time (days) relative to R−band peak
−20
−10
0
Fe II $^6D_{9/2}$ (ground level)
14
13.5
Fe II $^6D_{7/2}$ (1st excited)
@ 10 pc
log $N_{Fe\,II}$
13
@ 50 pc
12.5
@ 100 pc
12
−40
−30
−20
−10
0
10
Observed time (days) relative to R−band peak

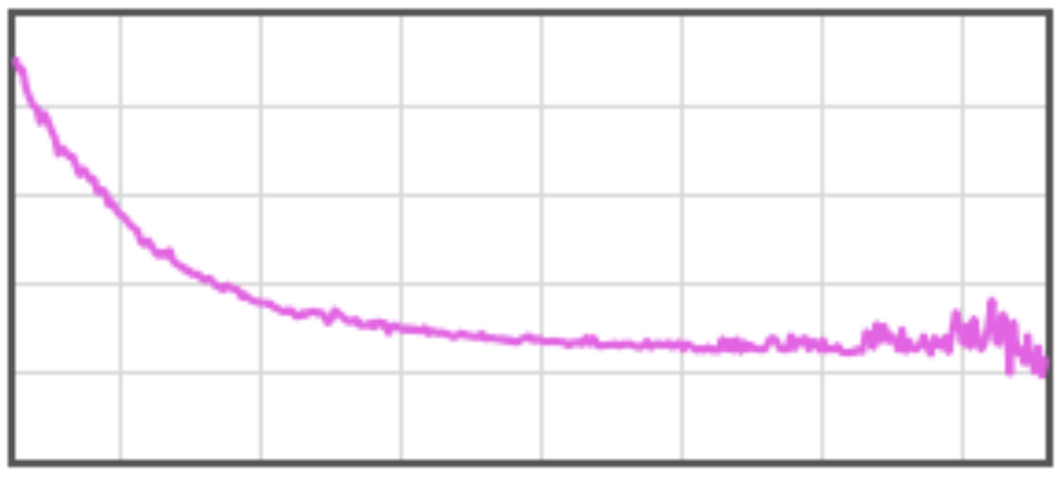
iPTF 13ajg summary

- a hydrogen-poor SLSN at redshift z=0.74
- M_u=-22.5, $L_{bol,peak}$=3x10^{44} erg s^{-1}, E_{rad}=1.3x10^{51} erg
- host galaxy: M_B = -18.4, with a stellar mass of ~ 10^9 $M_\odot$, but with a low star formation rate ($SFR_{[OII]}$ < 0.05 $M_\odot$ yr^{-1})
- X-shooter reveals narrow Mg I, Mg II and Fe II absorption lines, whose strength is low compared to GRB host galaxies
- fine-structure modelling: absorbing gas at least 50pc away from SN
- on-going X-shooter program to observe single iPTF SLSN this semester: 14aon!

iPTF 14aon: X-shooter triggered

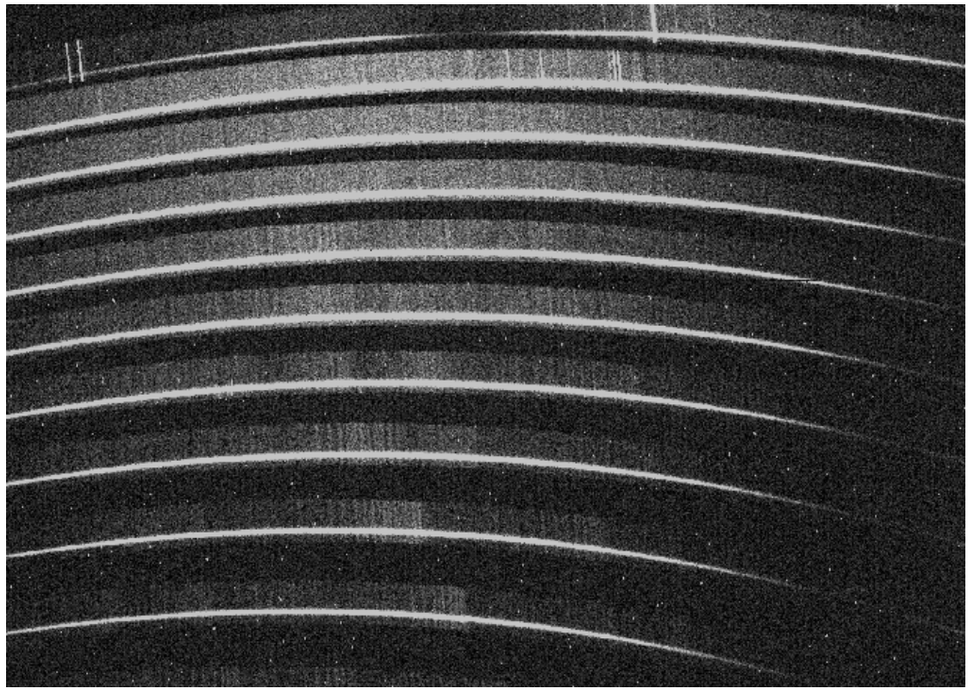




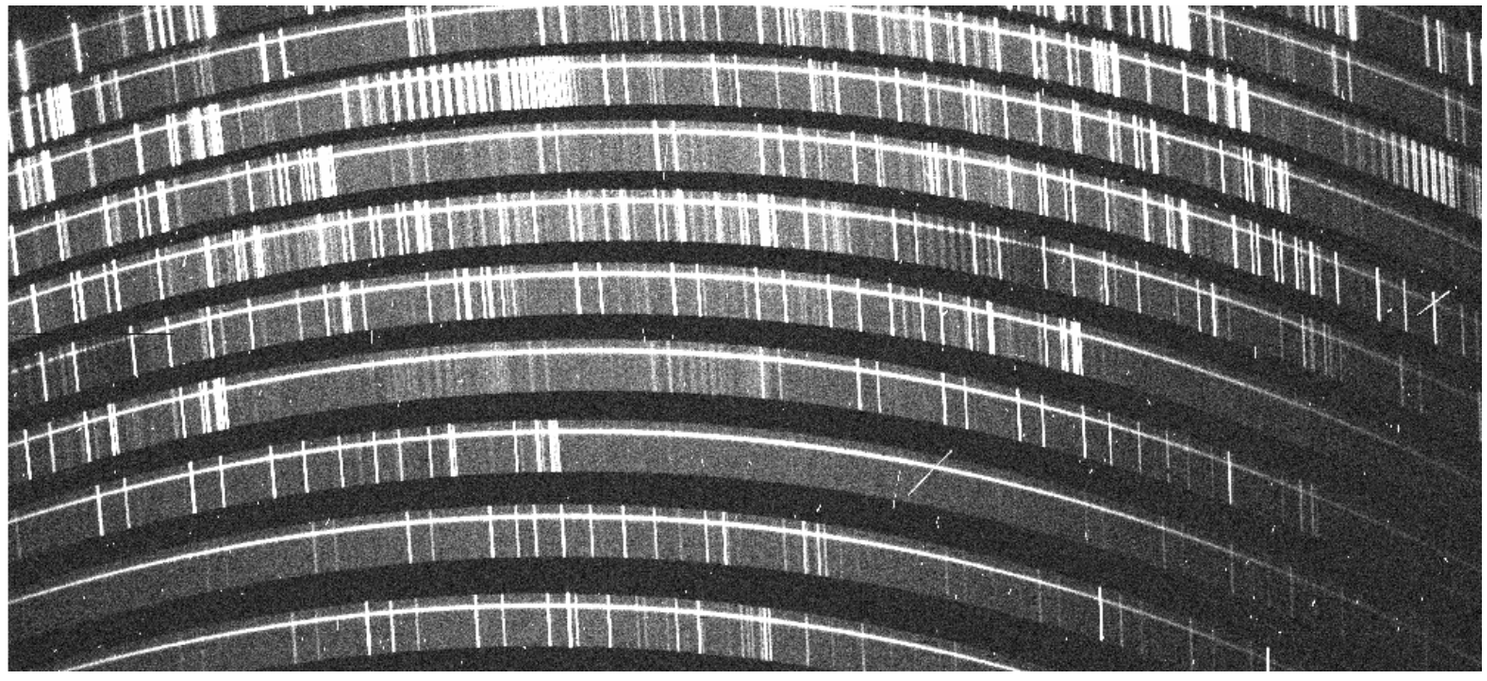


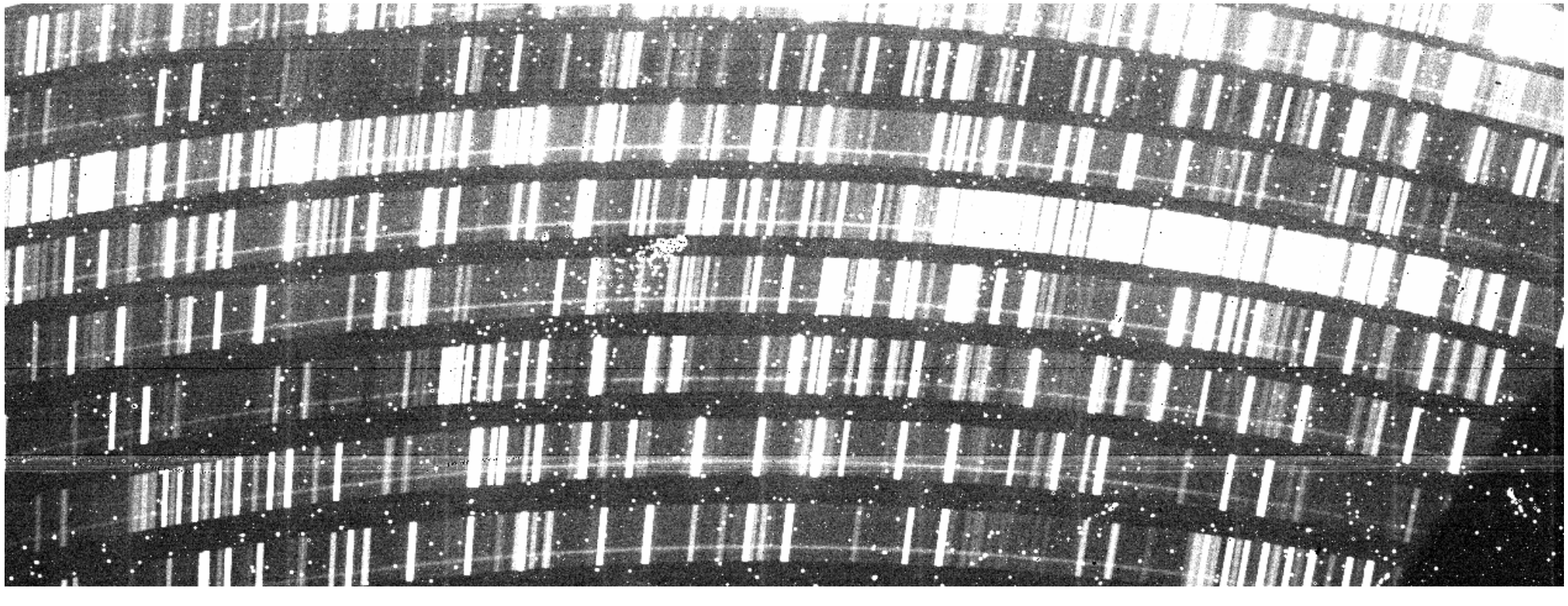
r = 19.4 (18.0 d) | Upload New Photometry

z = 0.49 | Upload New Spectroscopy
DM (approximate) = 42.22

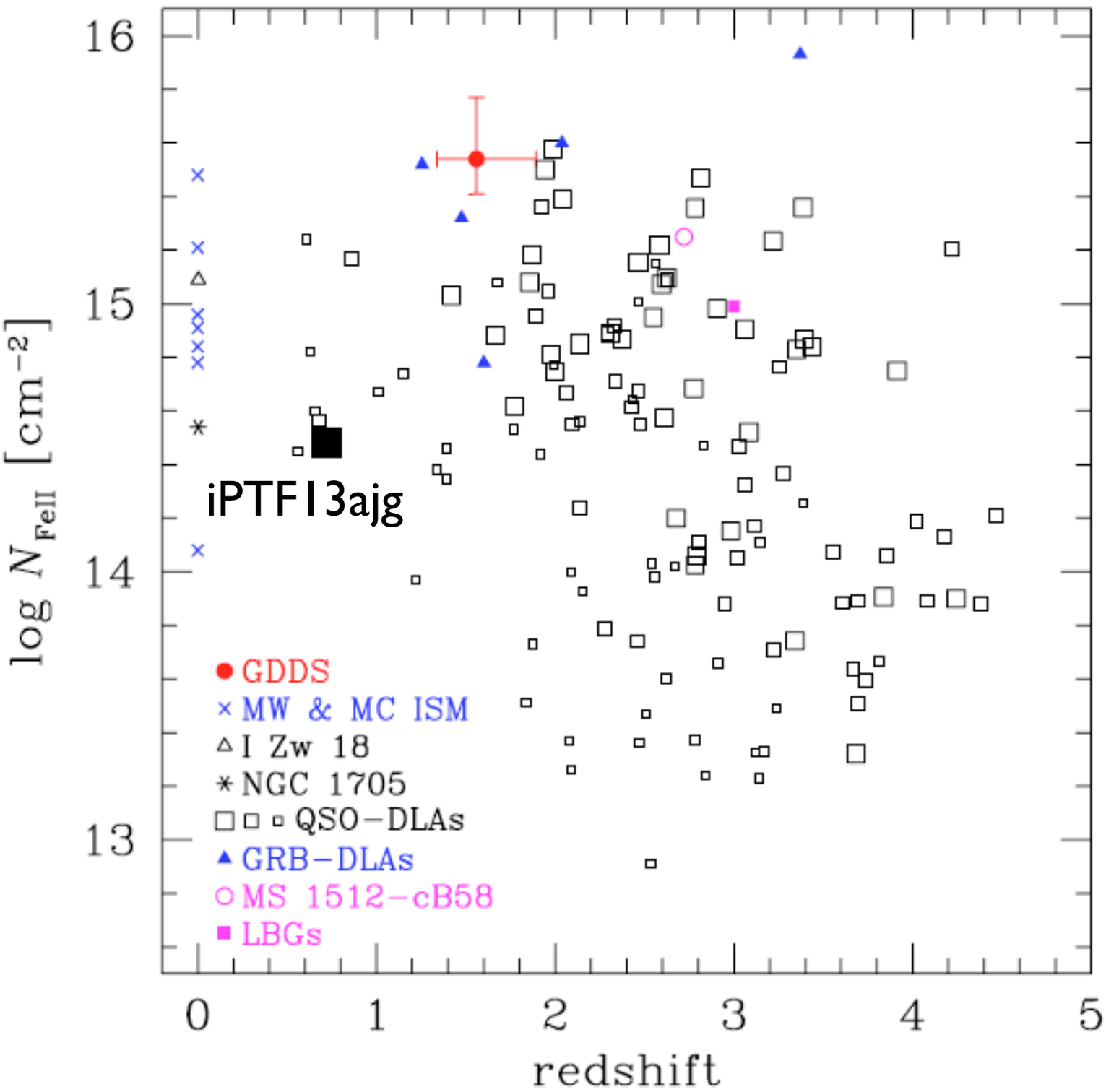


iPTF 14aon: yesterday's observations





Fe II column density in different environments



adapted from Savaglio et al. (2004)

iPTF13ajg: narrow UV absorption lines