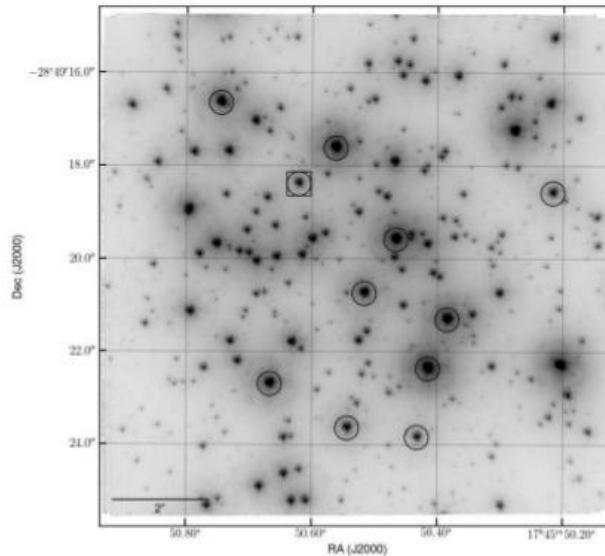
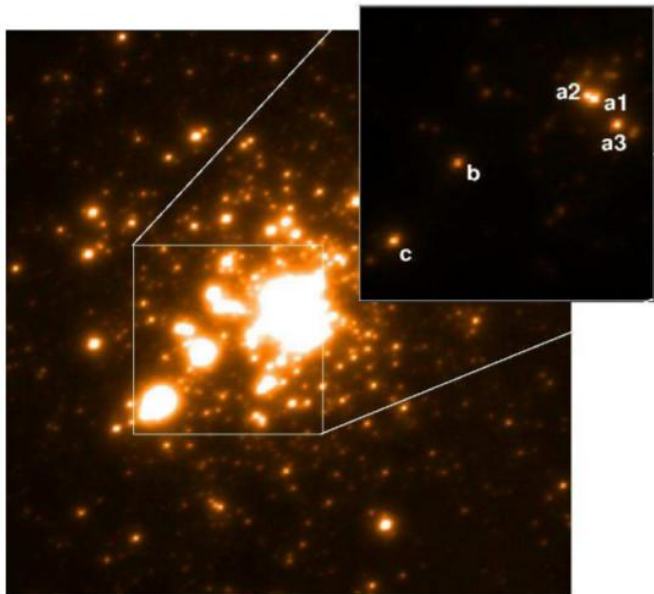
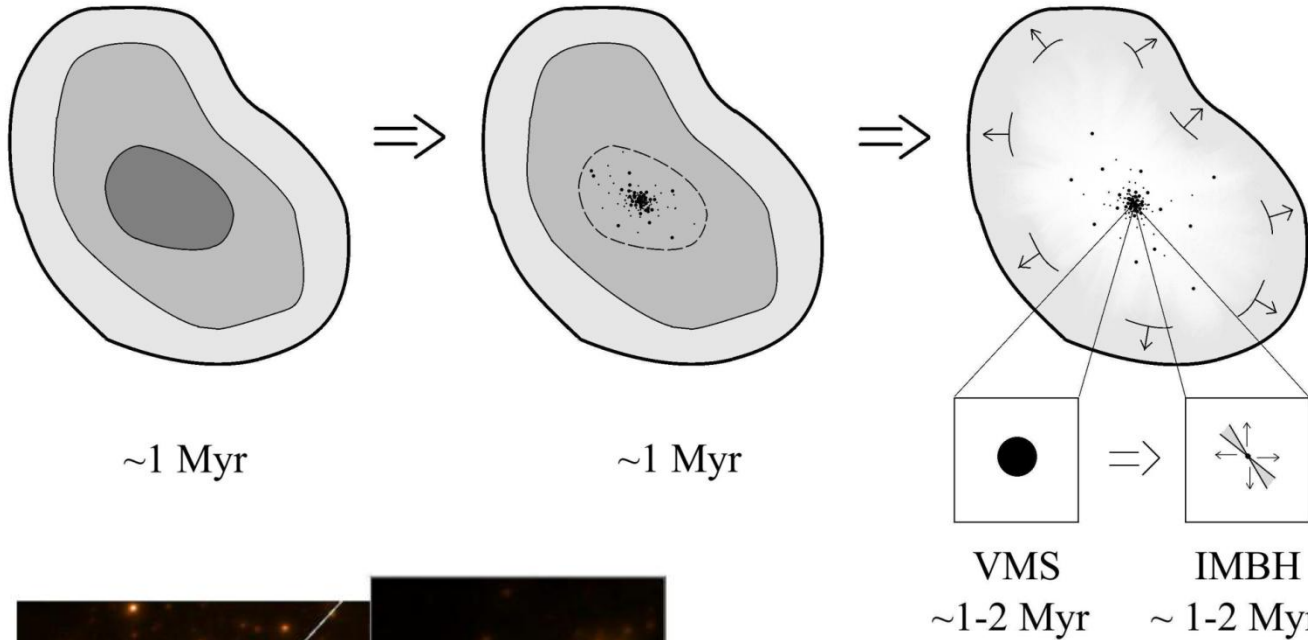


Very massive star and intermediate mass black hole

S. Fabrika, A. Vinokurov, Yu. Solovyeva, K. Atapin,
A. Kniazev, A. Kostenkov, O. Sholukhova

Short story of young cluster formation (SSC)



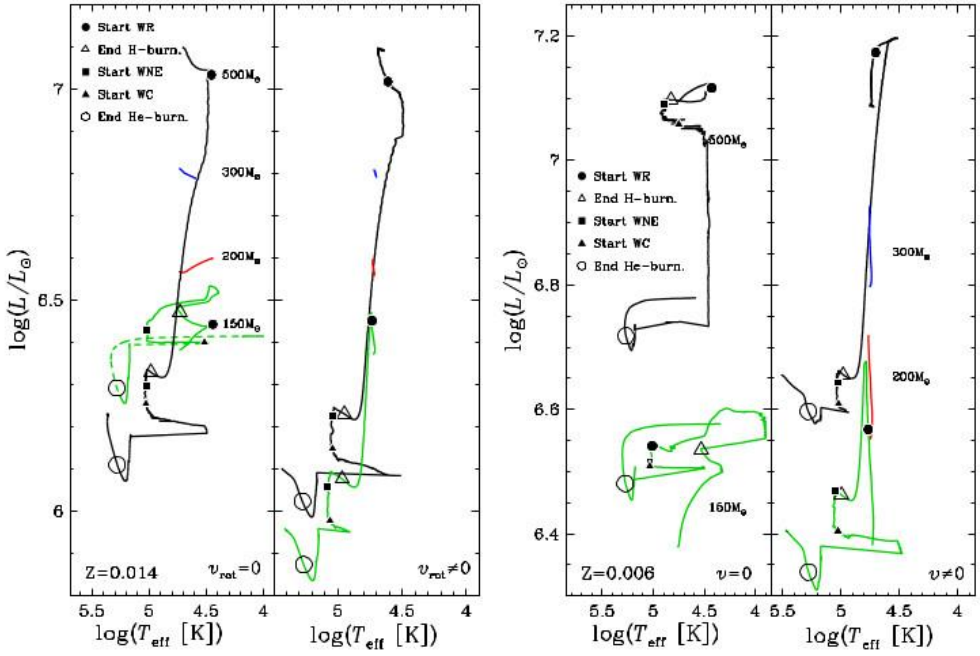
Arches/Galaxy:
Clarkson+12

IMF:
1 star 300 Msun,
300 stars > 50 Msun
In a cluster $3.3 \cdot 10^5$ Msun

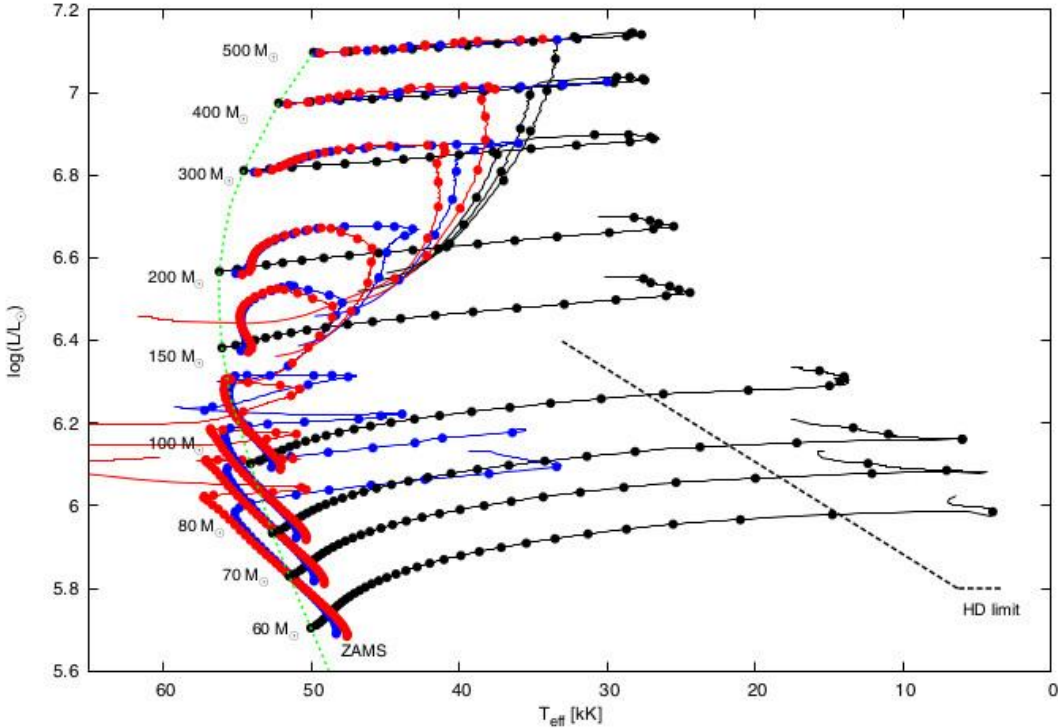
(Kroupa 01)

R136: Crowther+10, Campbell+10

Evolution tracks with VMS

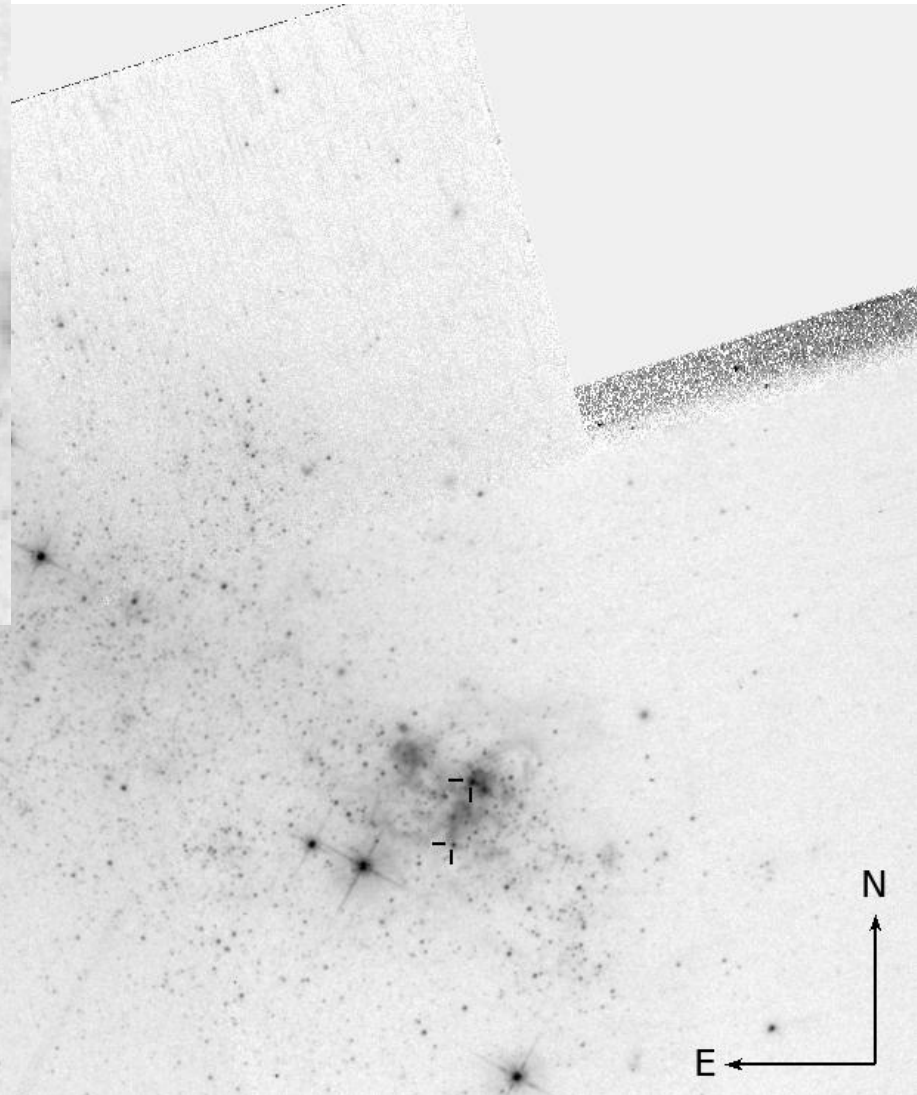
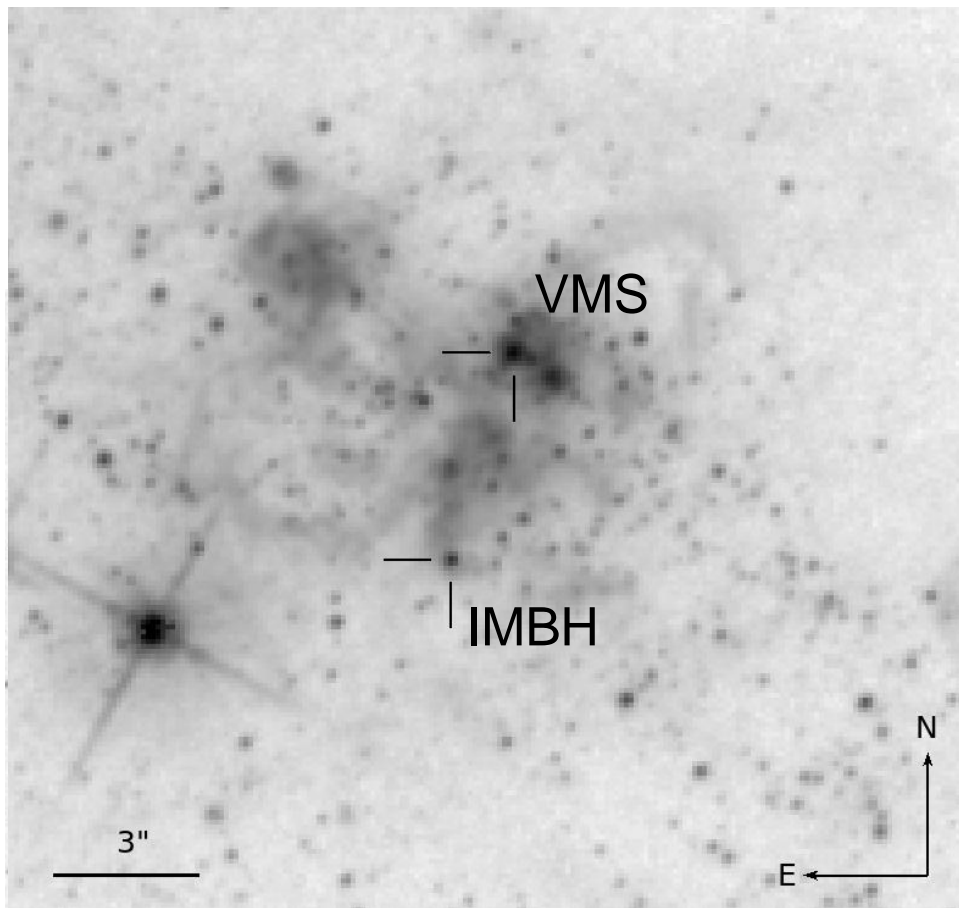


Yusof+13; LMC

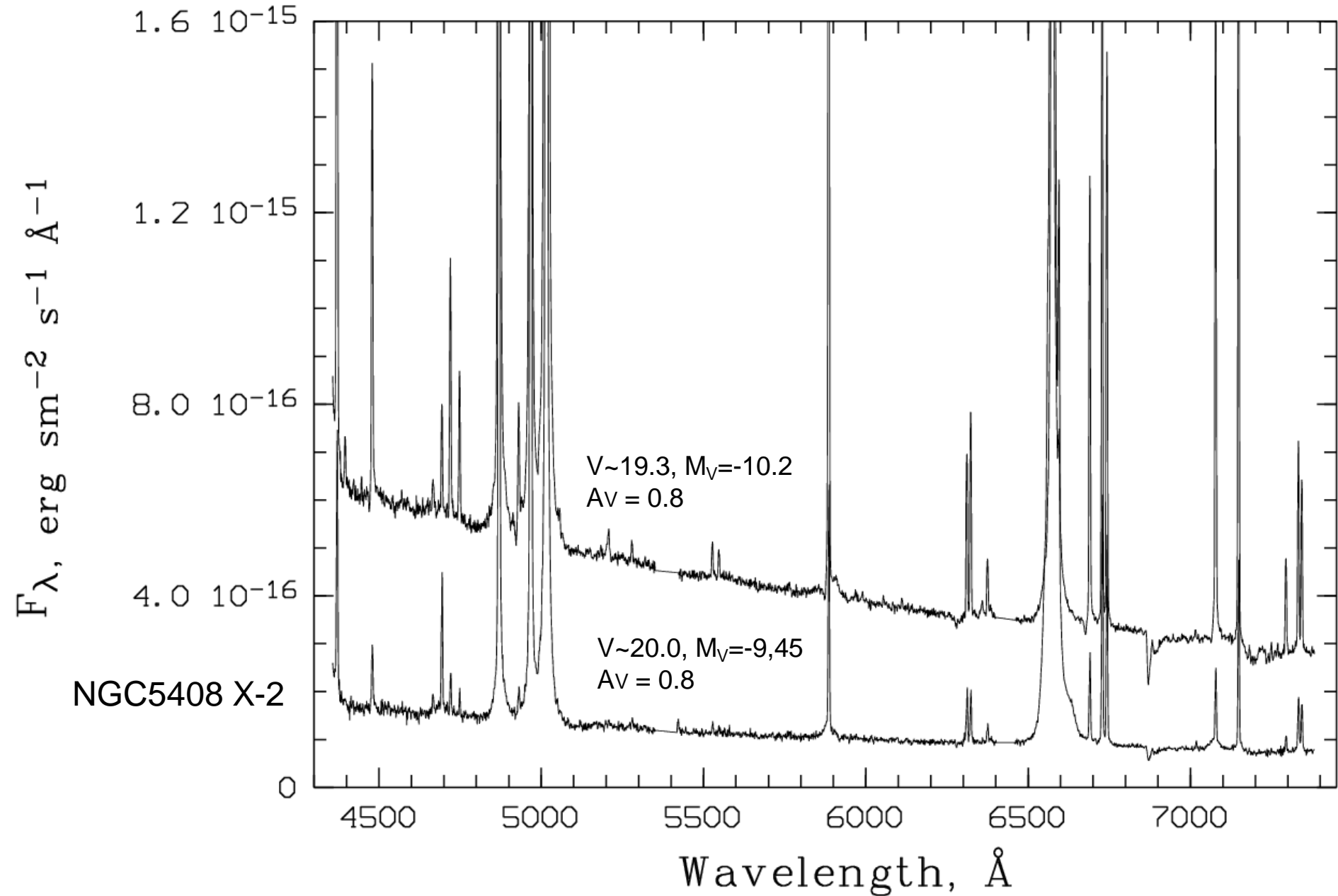


Köhler+15; LMC
 $V_{rot} = 0, 400, 500$ km/s

NGC5408
HST/WFPC2/F555W (V band)



NGC5408 (SALT)



Temperature ~ 25000 K

BC=2.3, $M_{\text{bol}} = -12.5$, $L_{\text{bol}} \sim 3 \cdot 10^{40}$ erg/s

All emission lines:

H α (FWHM) ~ 1300 km/s, H β ~ 1100 km/s; P Cyg = -1100 km/s

HeII ~ 5200 km/s

HeI ~ 1000 km/s; P Cyg = -1000 km/s

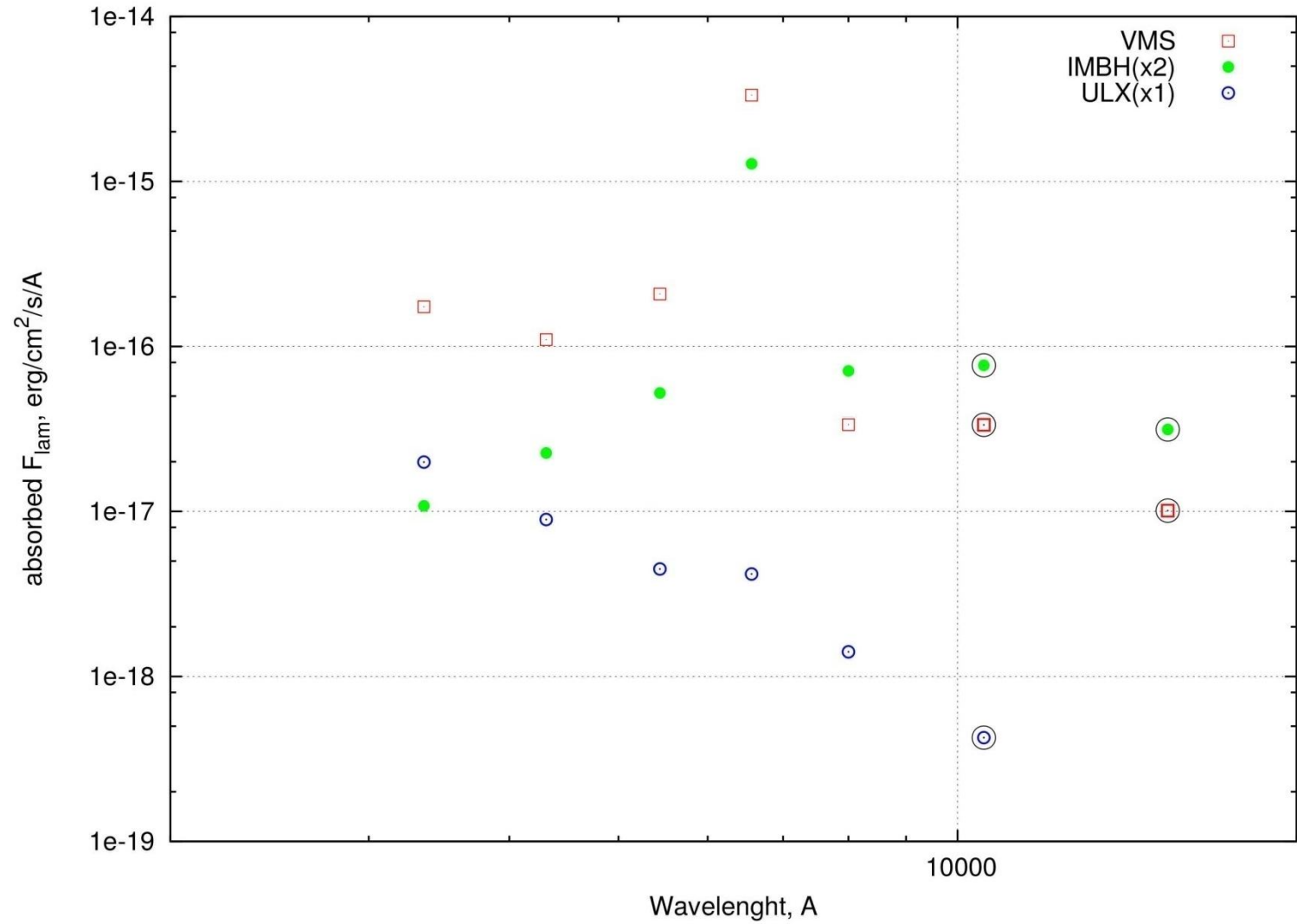
NIII/CIII, NIV, NaI_{D1,2}, SiII

Forbidden lines

Mg], [FeII], [FeIII], [ArIII], [ArIV], [SII], [KIV], [CIII]

The object does not exist in X-ray spectra

HST data



IMBH (NGC5408 X-2)

The optical spectra change dramatically:

in VLT data we find (12.04.2010)

H α , H β ... H8 (FWHM) \sim 2500 km/s, P Cyg = -1300 km/s

HeII (FWHM) \sim 3000 km/s

HeI (P Cyg) = -700 km/s, FeII = -800 km/s, CaII = -750 km/s (no emission lines)

The same VMS lines, but TiII, [TiII], MgII], [NII], [OII]

SALT (19.05.2017) H α , H β weak and narrow

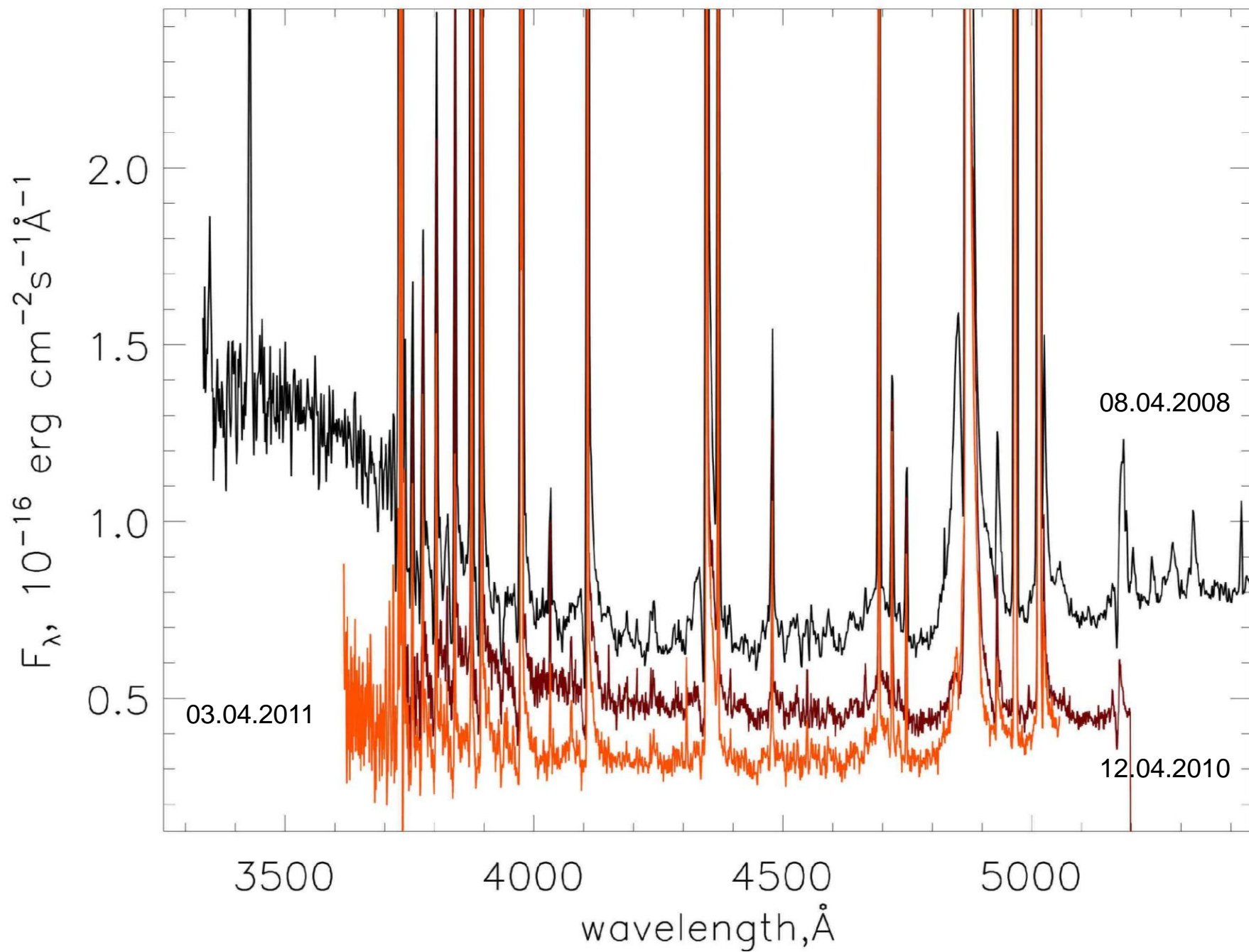
HeI the same with strong P Cyg -800 km/s

Temperature 39000 K

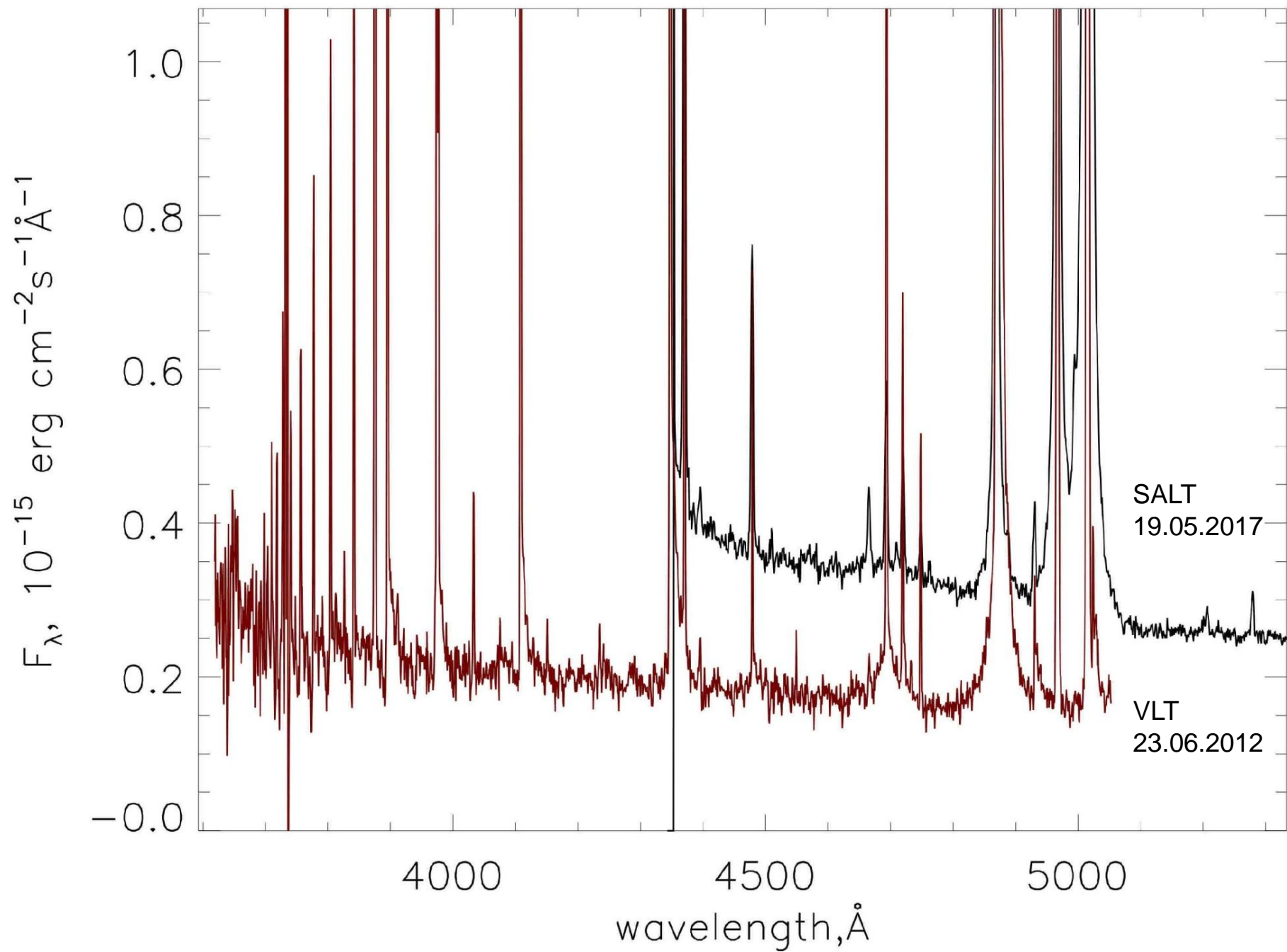
BC=3.6, M_{bol} = -13.0, L_{bol} \sim 5 10⁴⁰ erg/s

NGC5408 X-2/SS433 \sim 5 10⁴⁰ / 5 10³⁹ \sim 100 M_{sun}

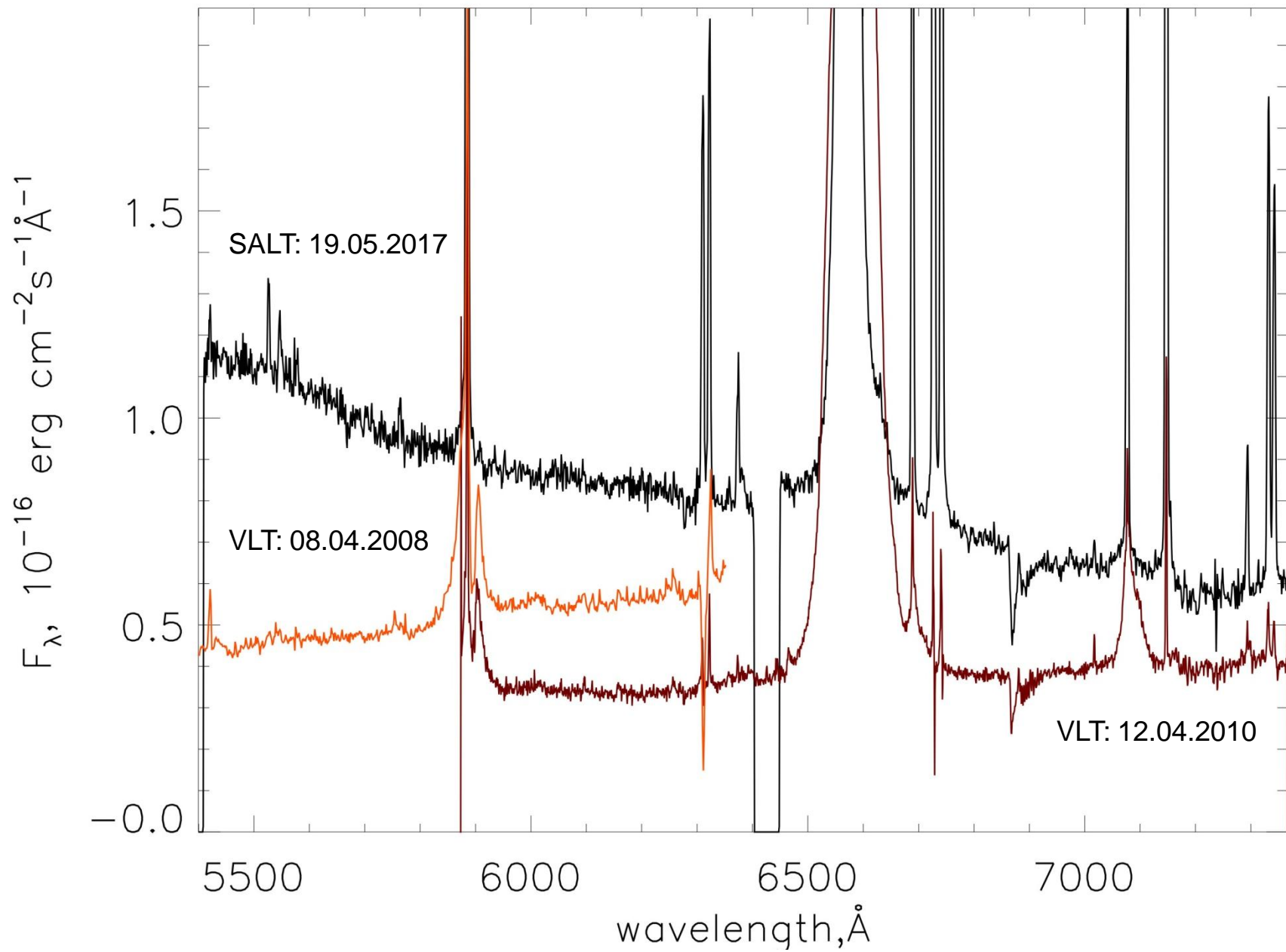
VLT



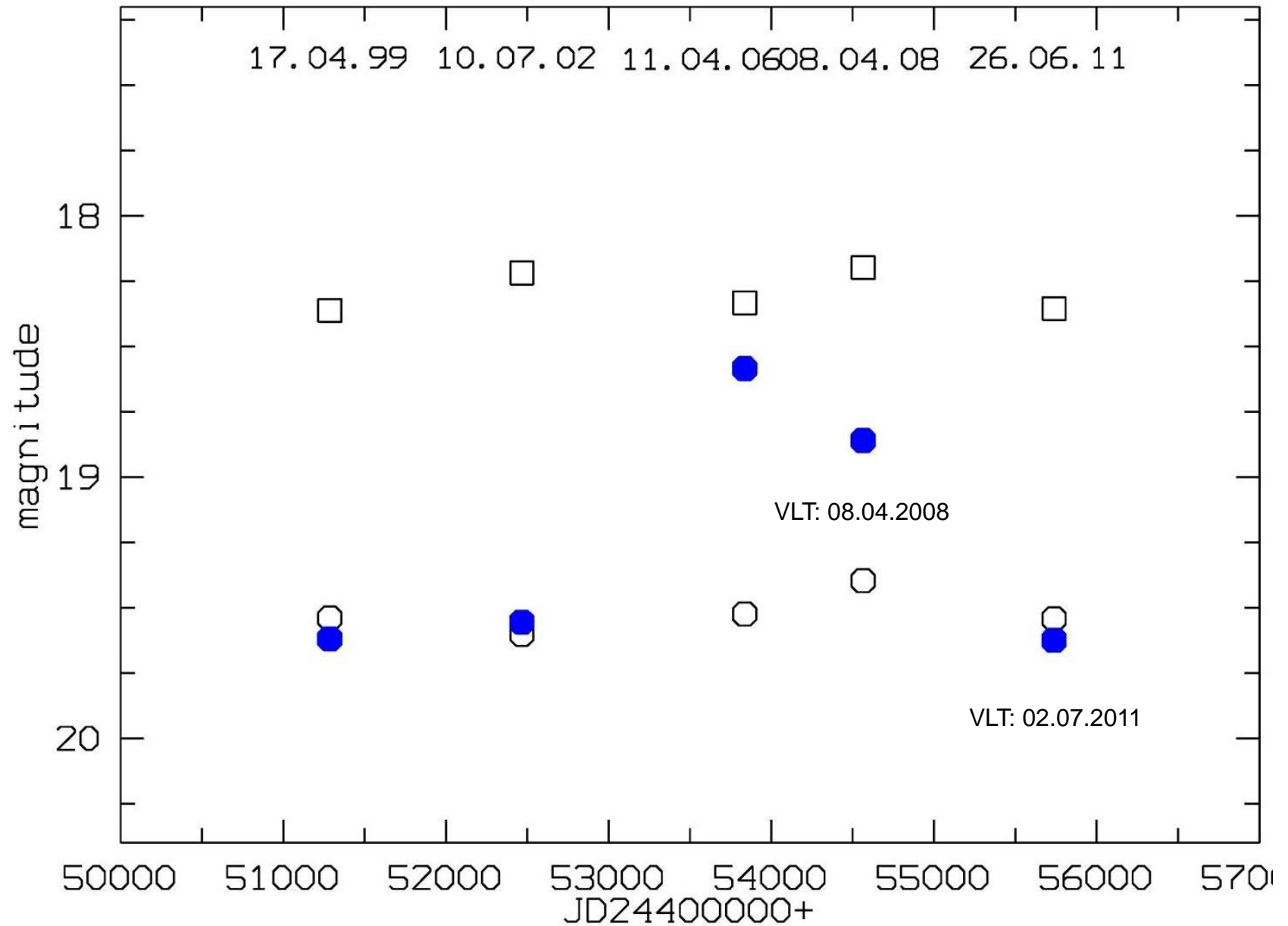
SALT/VLT



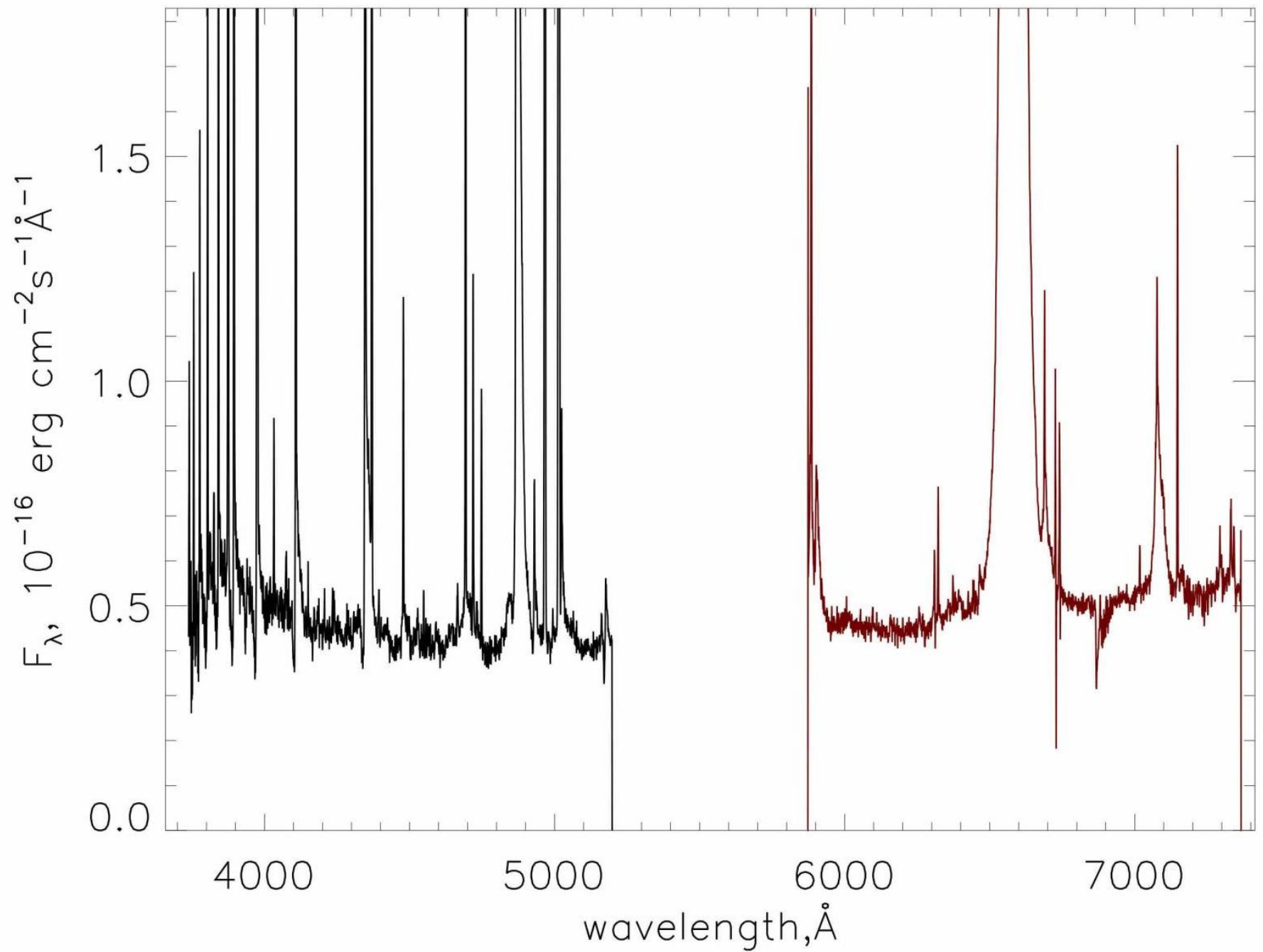
VLT/SALT



Photometry R-band (VLT)



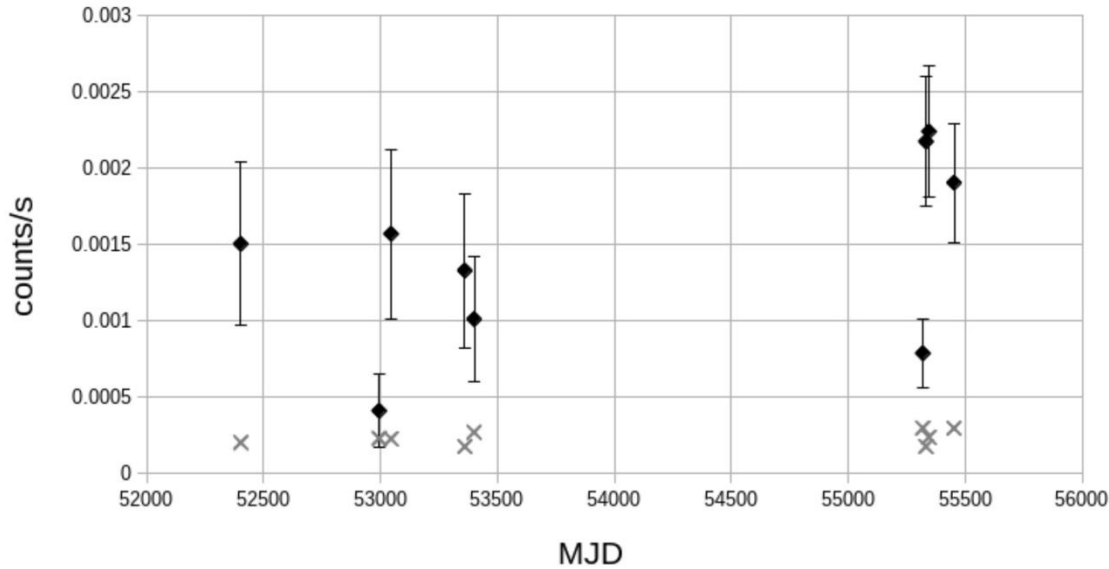
VLT: 12.04.2010



IMBH (NGC5408 X-2)

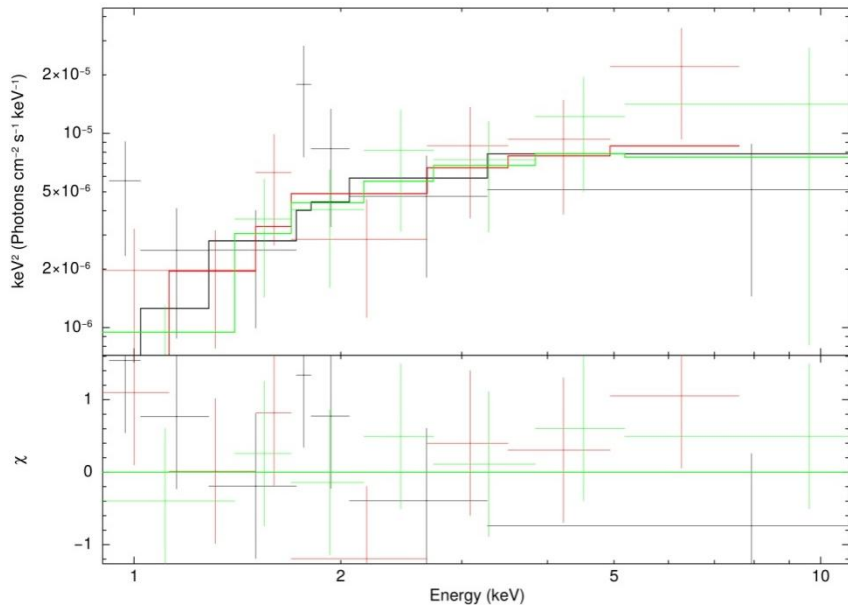
Chandra LC

X-ray variability



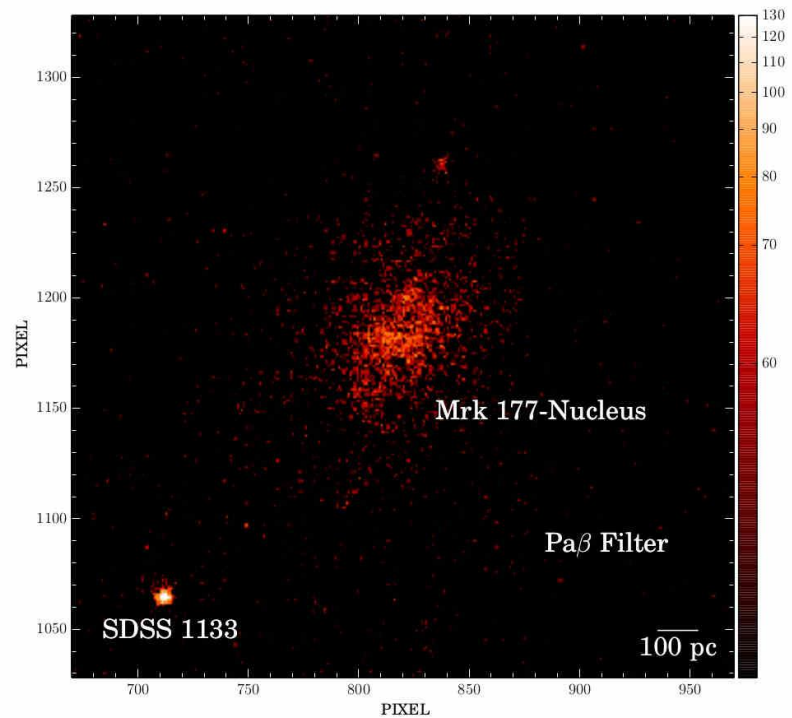
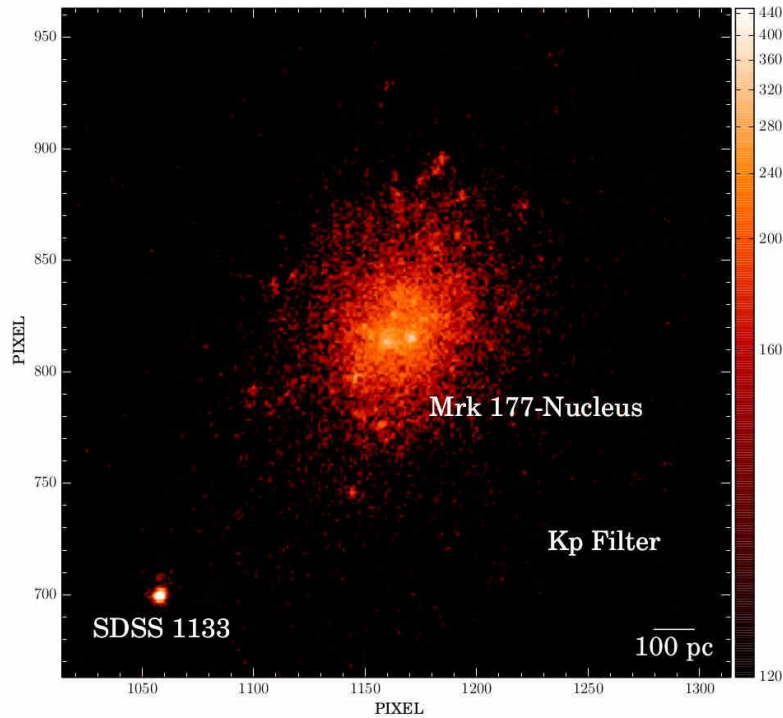
X-ray spectra

Unfolded Spectrum



$\Gamma=1.2$, 0.3-10 keV
 $L_x = 1.1 \cdot 10^{38}$ erg/s
 $L_x/L_{bol} \sim 0.002$
(the funnel wind)

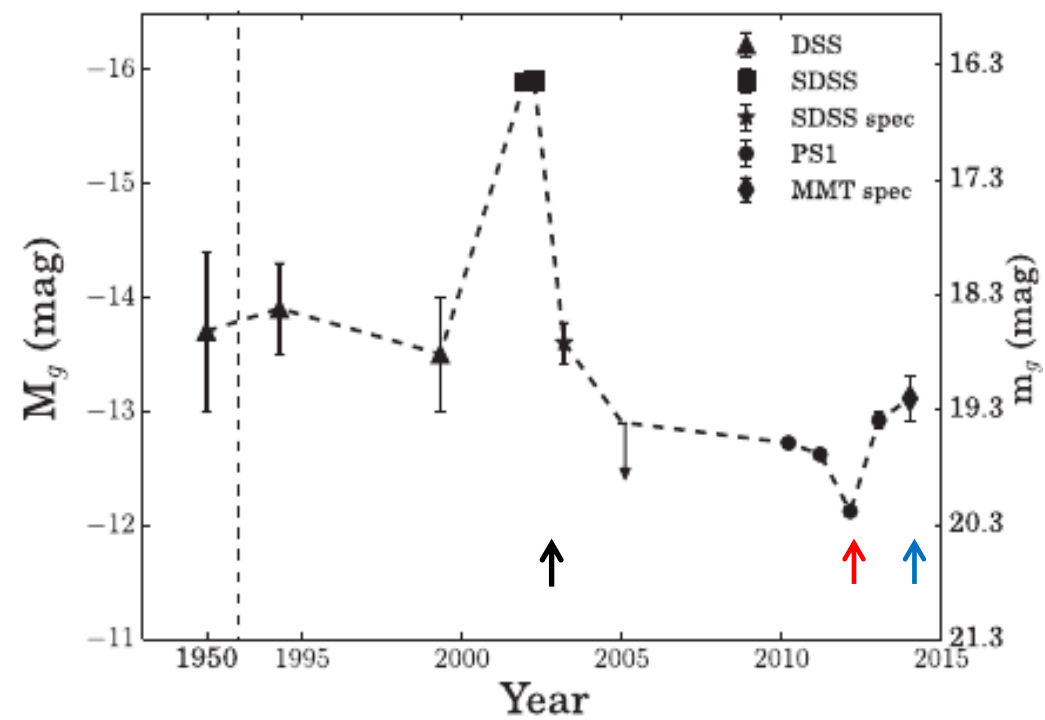
In SS433: $L_x/L_{bol} \sim 0.0002$
(the funnel wind totally covered)



Adaptive Optics (AO) image
Near Infrared Camera 2 (NIRC2)
Keck-2

12", FWHM = 0.08"

g band photometry



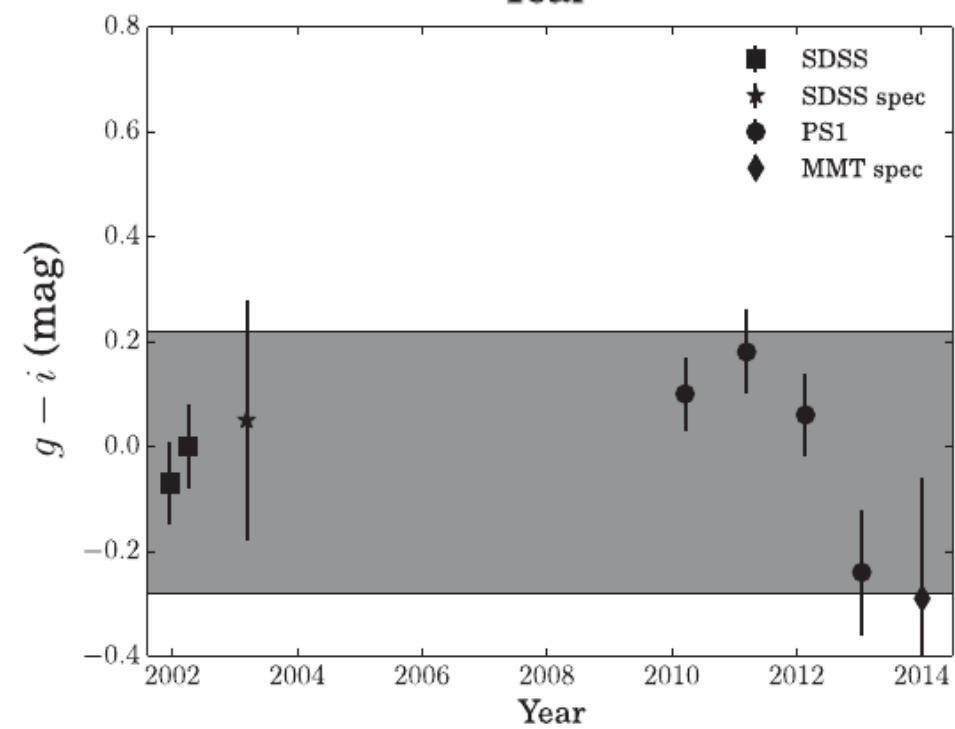
Optical spectra:

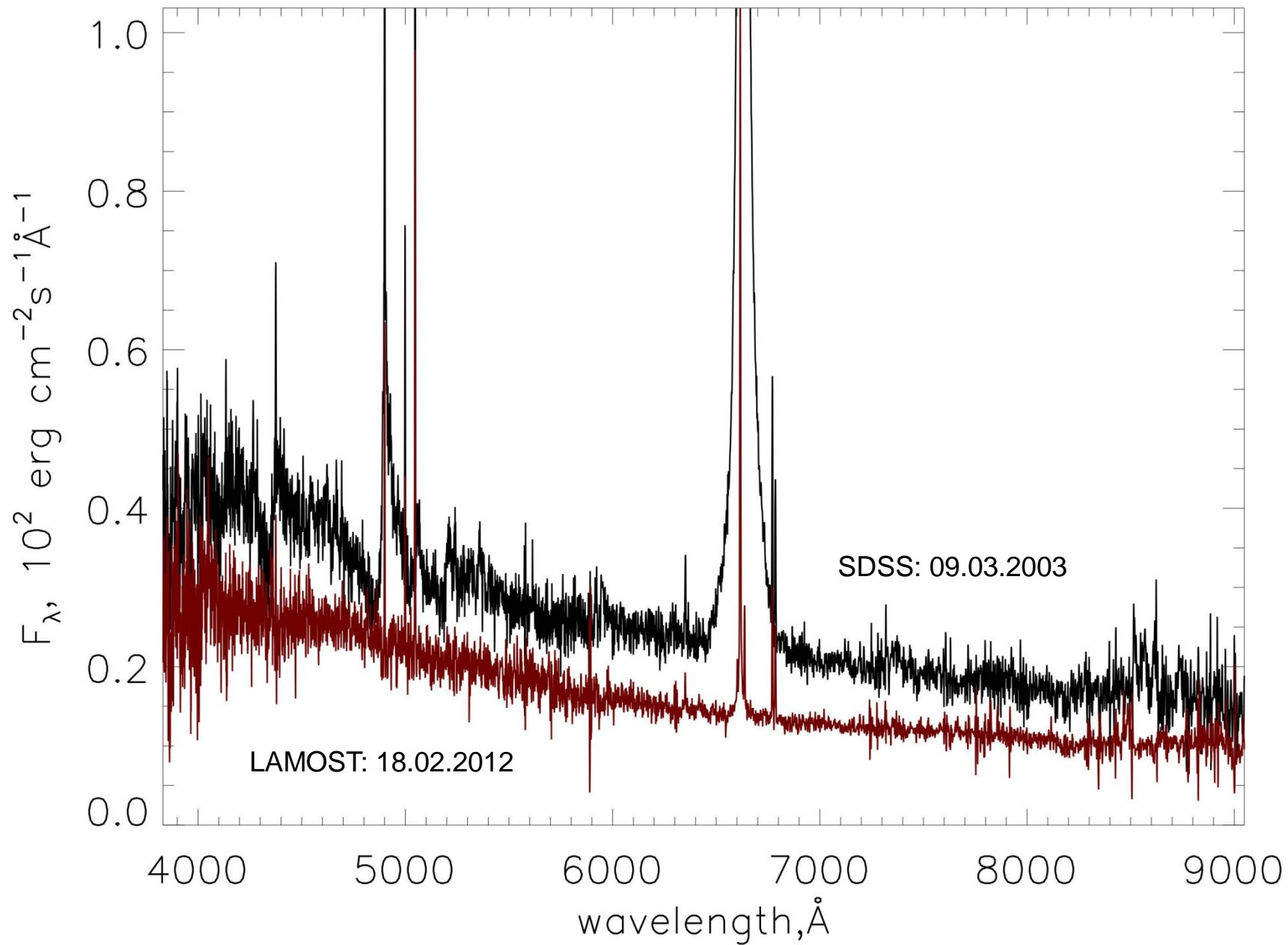
SDSS: 09.03.2003

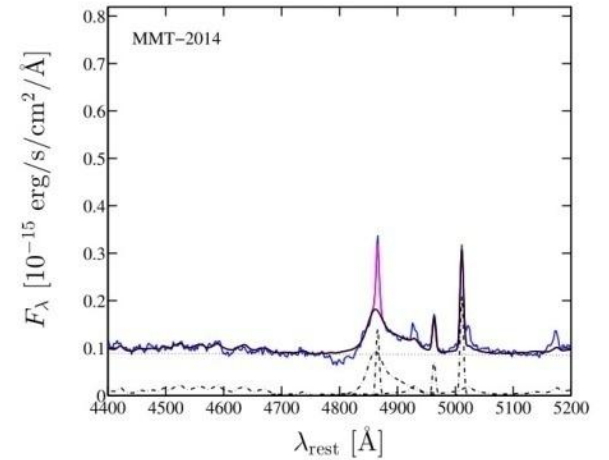
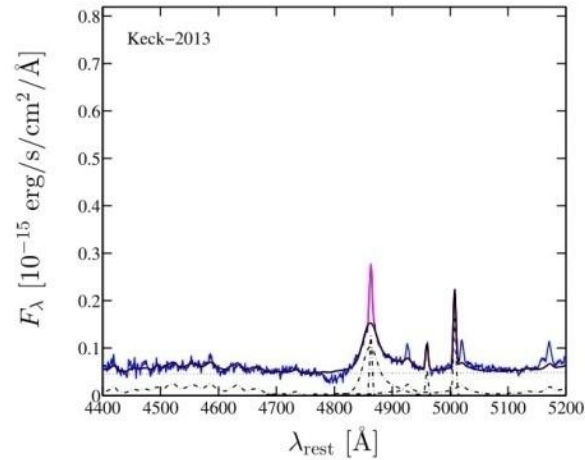
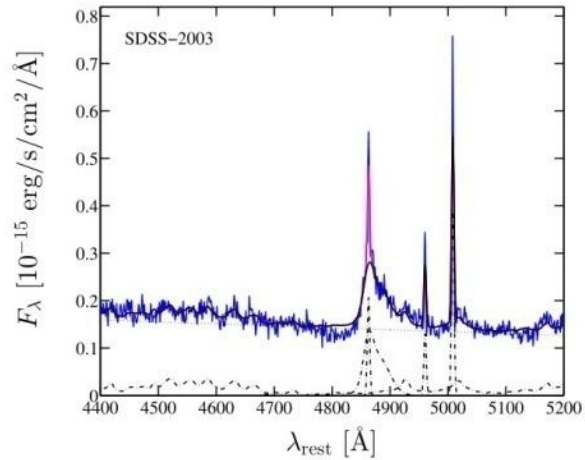
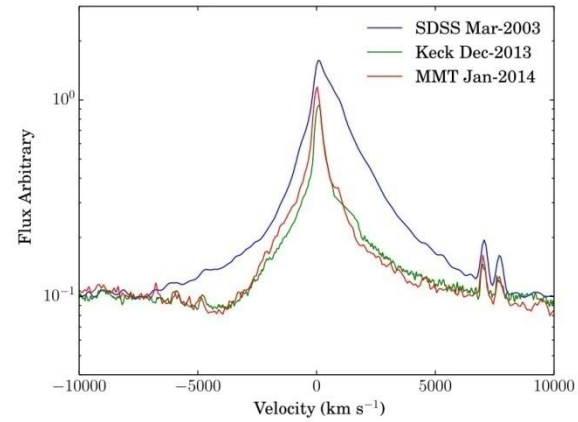
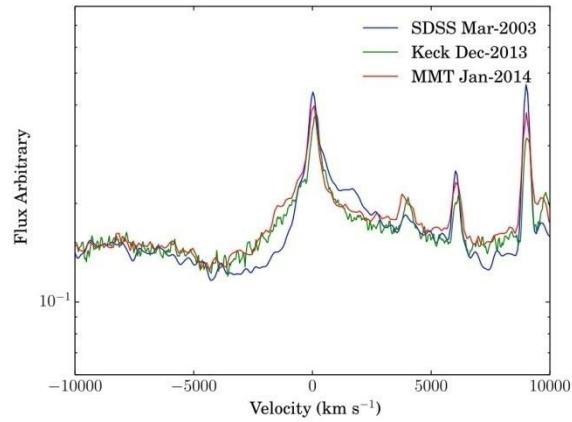
LAMOST: 18.02.2012

Keck-II: 13.12.2013

MMT: 03.01.2014







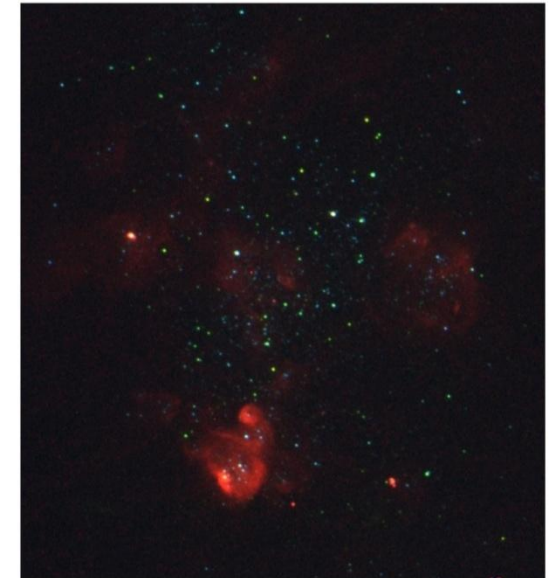
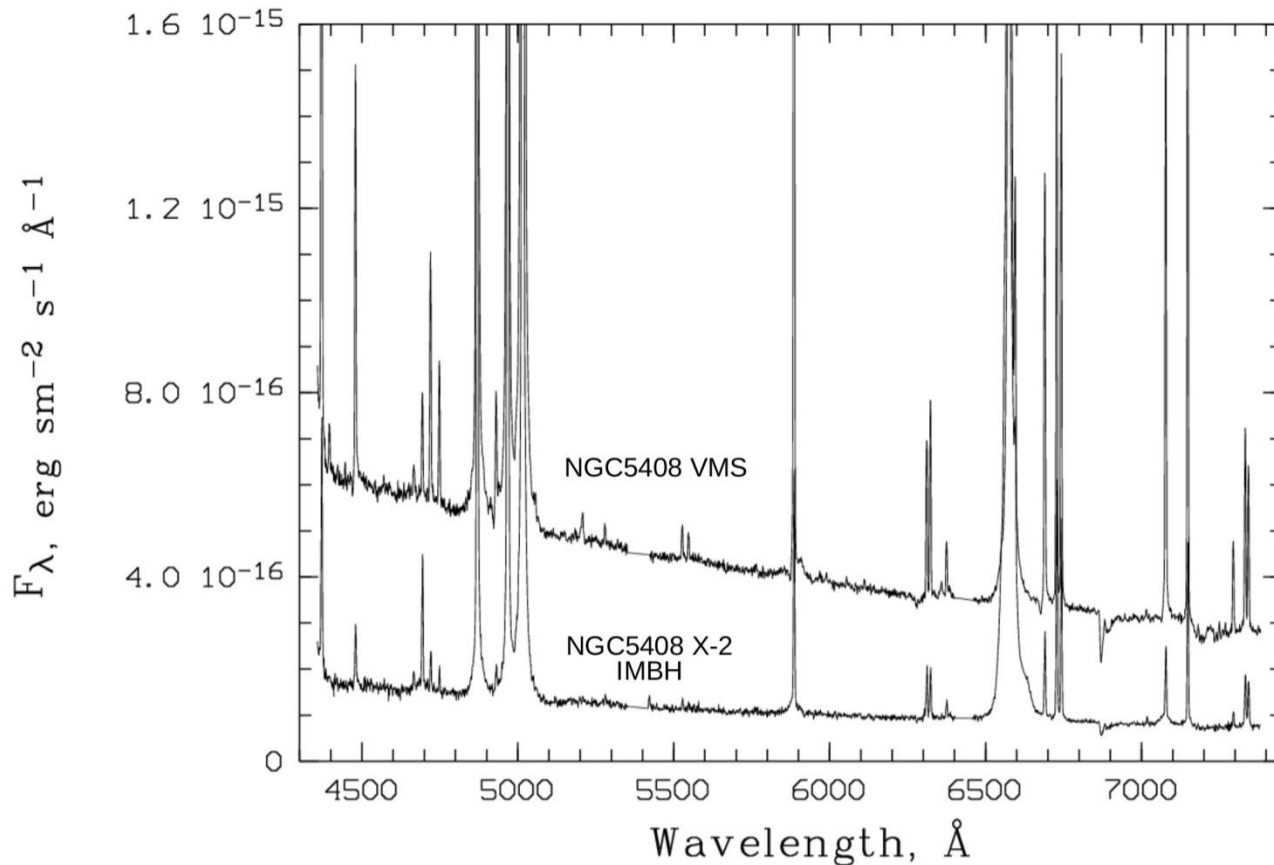
$AV \sim 0$, $BC = -1.2$, $Mg = -13.6$, $M_{bol} = -14.8$

Temperature 16000 K

$L_{bol} = 2.5 \cdot 10^{41}$ erg/s, $L_x < 1.5 \cdot 10^{39}$ erg/s

SDSS1133/SS433 $\sim 2.5 \cdot 10^{41} / 5 \cdot 10^{39} \sim 500 M_{sun}$

The joint project with SAO RAS and SAAO



NGC5408 $D=4,9$ Mpc

NGC5408: very massive star $V=17.5$, $M_V \sim -11$, $M_{\text{bol}} \sim -15$

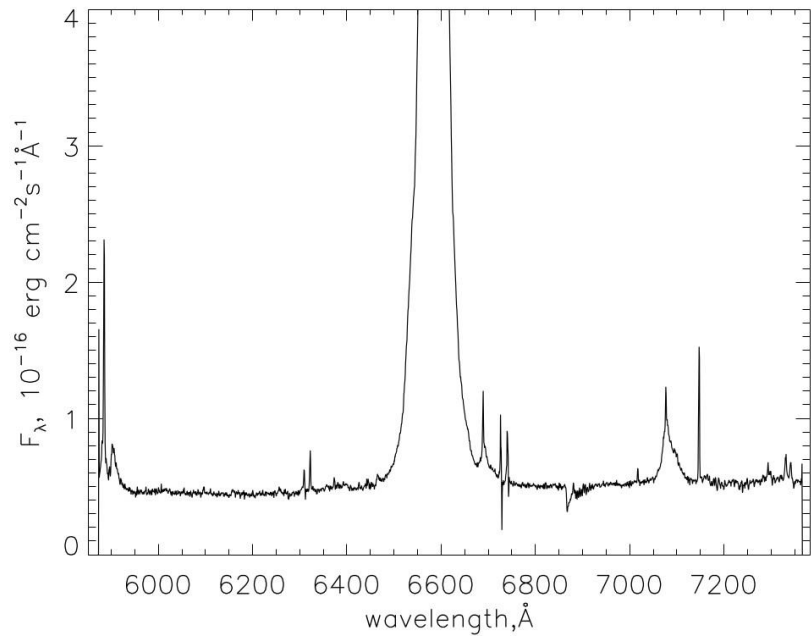
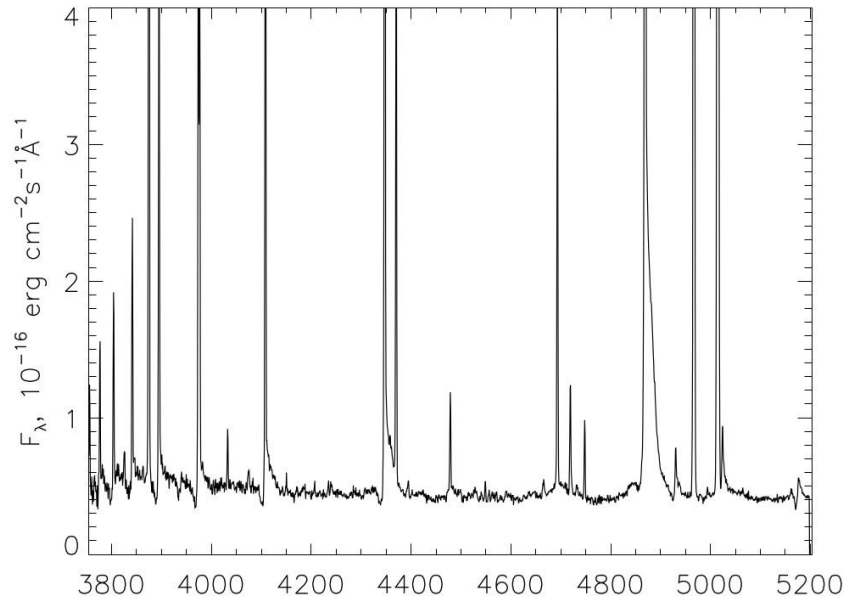
NGC5408: X-2 intermediate mass black hole $V=19.5$, $M_V \sim -9$, $M_{\text{bol}} = -14 - -15$

Both objects have a luminosity about $10^8 L_{\text{sun}}$. They are single and variable objects.

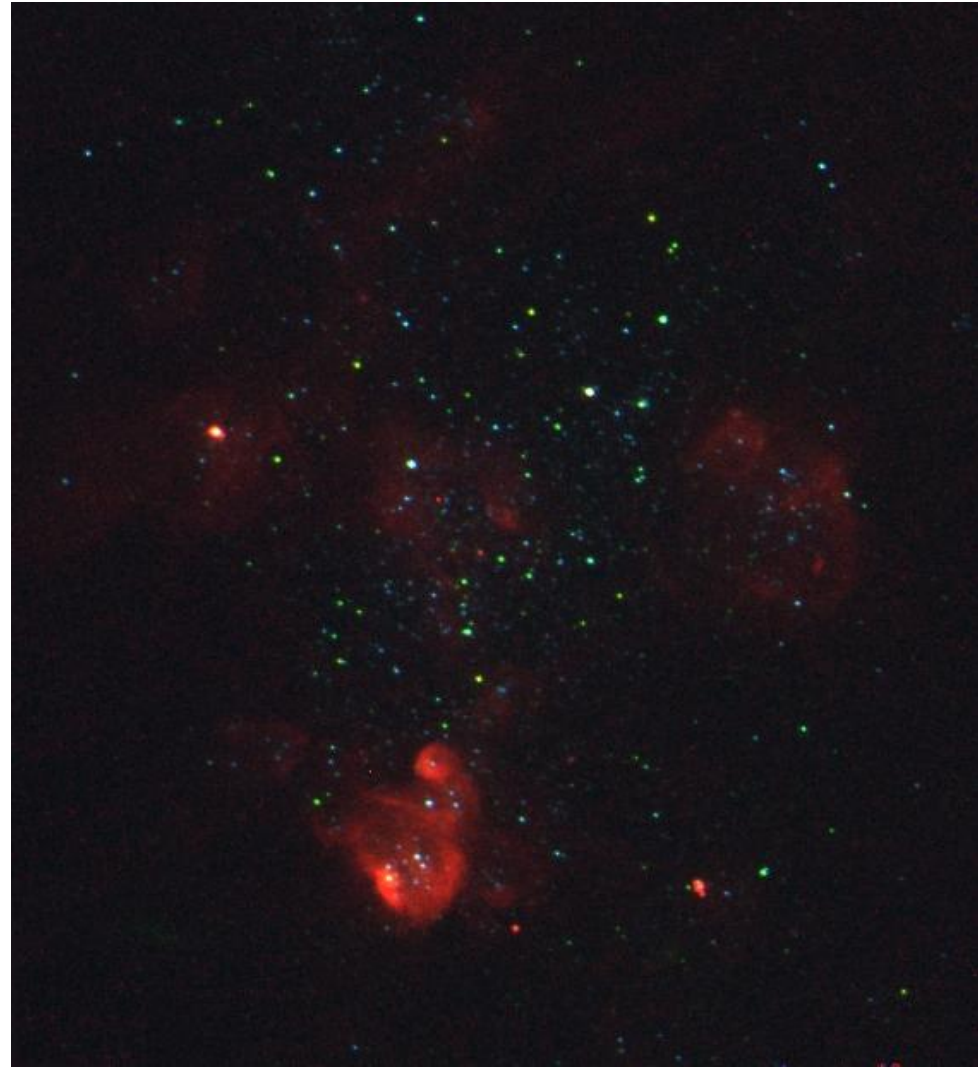
VMS: no X-rays

IMBH: very variable in X-rays, it looks like SS433, but with 200 solar masses black hole.

NGC5408 X-2



New types of objects in clusters



The object spectrum $\sim 10^8 L_{\text{sun}}$

спасибо