Long term O/IR lightcurve of A0620-00

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(plus dozens of observers and students over the decades)
A0620-00: the “typical” low mass BH transient

Elvis et al. 1975

Matilski et al. 1976
A0620-00: the “typical” low mass BH transient

McClintock & Remillard 1986

Neilsen, Steeghs & Vrtilek 2008
the "typical" low mass BH transient

\[ f = \frac{PK^3}{2\pi G} = \frac{M_{BH} \sin^3 i}{(1 + \frac{M_2}{M_{BH}})^2} \leq M_{BH} \]

A0620-00
\[ P = 7.7\ldots \text{ hours} \]
\[ K = 425 \text{ km/s} \]
\[ f = 3.1M_\odot \]
Disk Instability Mechanism (DIM)

• Key to the demographics and evolution of transient LMXBs.

• Quiescence: $\dot{M}_{\text{disk}} < \dot{M}$, so material piles up in the disk, and accretion onto compact object is very low.

• As disk gets denser and heats up, a threshold is passed (generally associated with ionization) and the viscosity greatly increases, leading to much greater $\dot{M}_{\text{disk}}$.

• Outburst: Disk "flushes" onto the accreting object.

• Complexities
  • Irradiation
  • Non-disk accretion flows
  • Propagation of heating and cooling flows
SMARTS ANDICAM Observations

- Optical+IR imager
- Optimized for queue observing
- 1998-2002 on Yale 1m
- 2003-present on 2MASS 1.3m

LMXB Observations

- Near nightly observations:
  - A0620-00
  - GRO J1655-40
  - GX 339-4 - Buxton+ 2012
  - GRS 1915+105 (K only) – Neal+ 2007
  - 4U1543-47
  - SAX 1819-2525 (V4641 Sgr) - MacDonald+ 2014
  - GRS 1124-68 (Nova Mus ‘91) – Wu+ 2016
  - Neutron stars: Aql X-1, Cen X-4
A0620-00 20 year light curve

Micro Jy

HJD

B

V

I

H
A0620-00 20 year light curve

"active" state
(Cantrell+ 2010)

"passive" state
A0620-00 20 year folded light curve

Micro Jy

phase
A0620-00 20 year folded light curve

Pure ellipsoidal model
Cantrell et al. 2010
A0620-00 20 year folded light curve:
Total flux

MJD < 54000

MJD > 55000
A0620-00 20 year folded light curve:
Non-ellipsoidal flux

MJD < 54000

MJD > 55000
A0620-00 20 year folded light curve

Pure ellipsoidal model
Cantrell et al. 2010
A0620-00 20 year folded light curve

Pure ellipsoidal model
Cantrell et al. 2010
A0620-00 color-brightness

- Star redder than non-ellipsoidal flux
- Non-ellipsoidal flux is redder when brighter.
A0620-00 color-brightness

• Star redder than non-ellipsoidal flux
• Non-ellipsoidal flux is redder when brighter.

• Non-ellipsoidal flux likely non-thermal
• Activity in the active quiescent state possibly from jet...
• Known to have short timescales
Jets in A0620 in quiescence

Figure 3: Radio and X-ray luminosities of A0620-00.
Conclusions thus far...

• O/IR activity generally increases during quiescence
  • Frequency and intensity of quiescent “active” phase increase
  • Significant night-to-night changes in non-ellipsoidal activity
  • Stochastic overall activity level changes on annual timescales
  • Clear trend on decadal timescales
• Orbital signature of non-ellipsoidal flux can show dramatic changes
• Non-ellipsoidal flux trends redder when brighter – likely dominated by non-thermal emission
• Hypothesis: several light sources contribute to non-ellipsoidal light
  • Disk (traditional interpretation)
  • Irradiation of secondary??
  • Much activity likely due to non-thermal (“jet”) emission