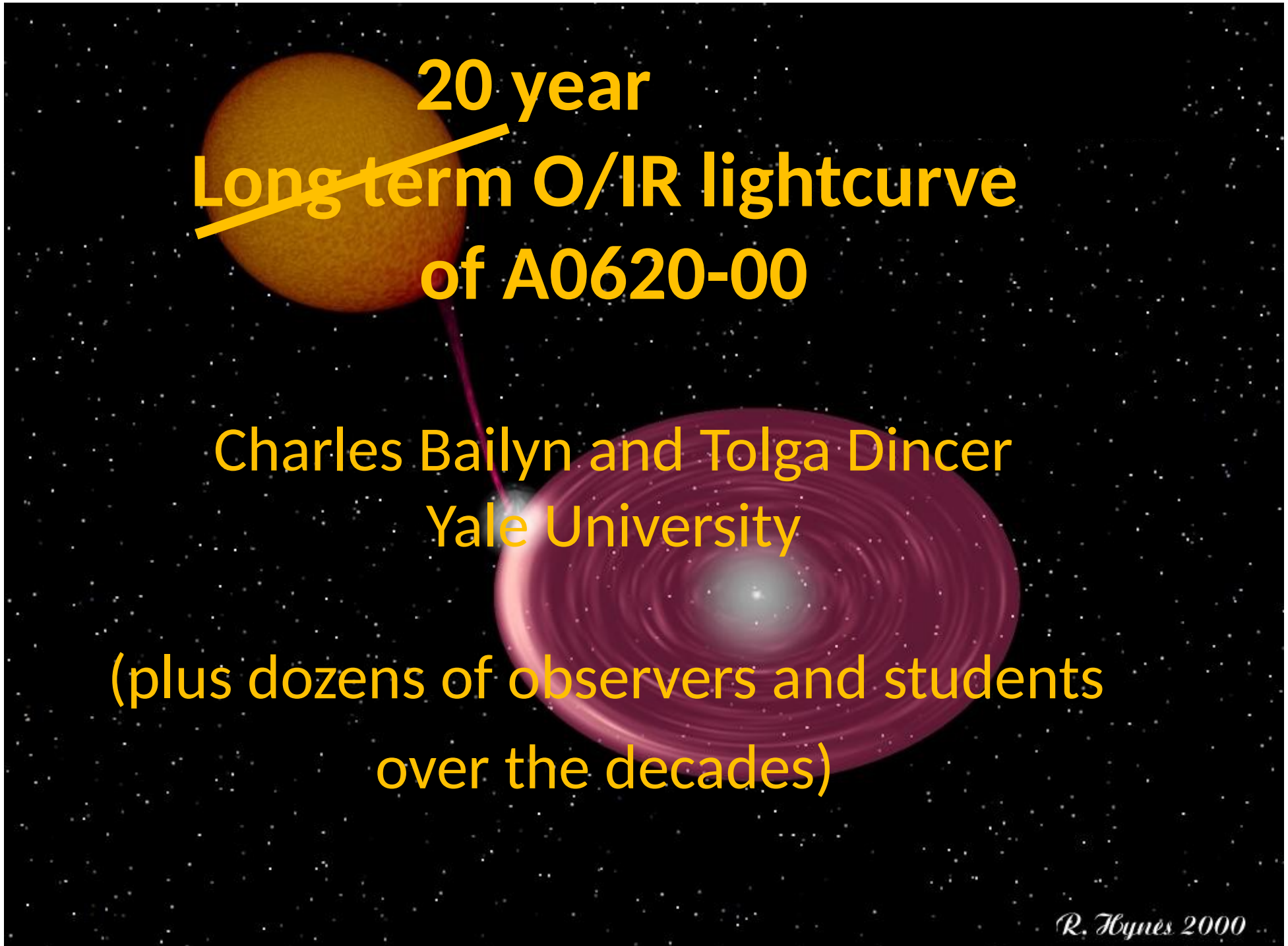
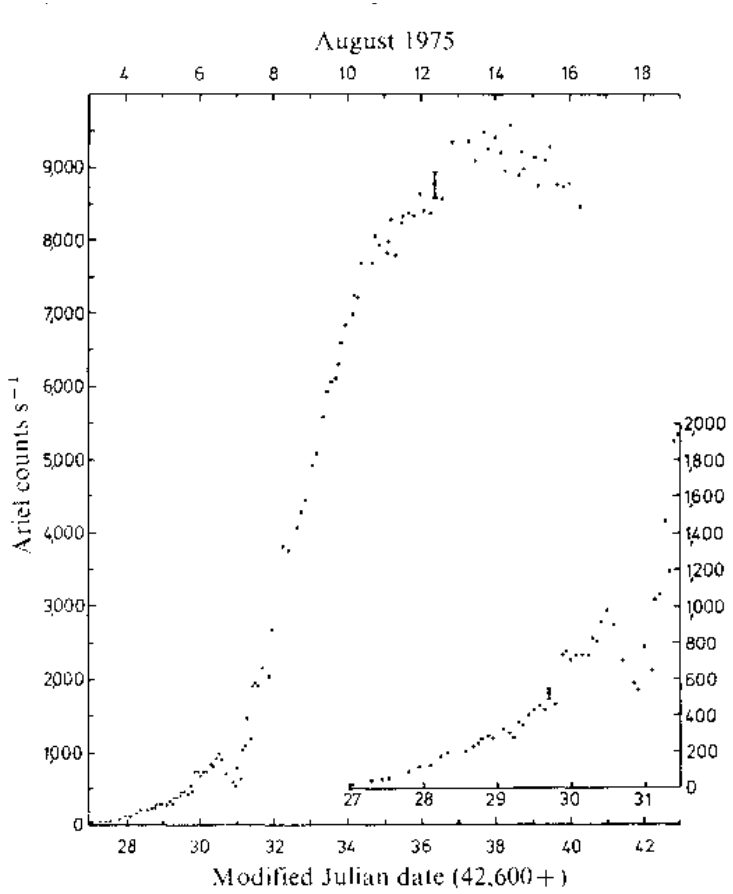
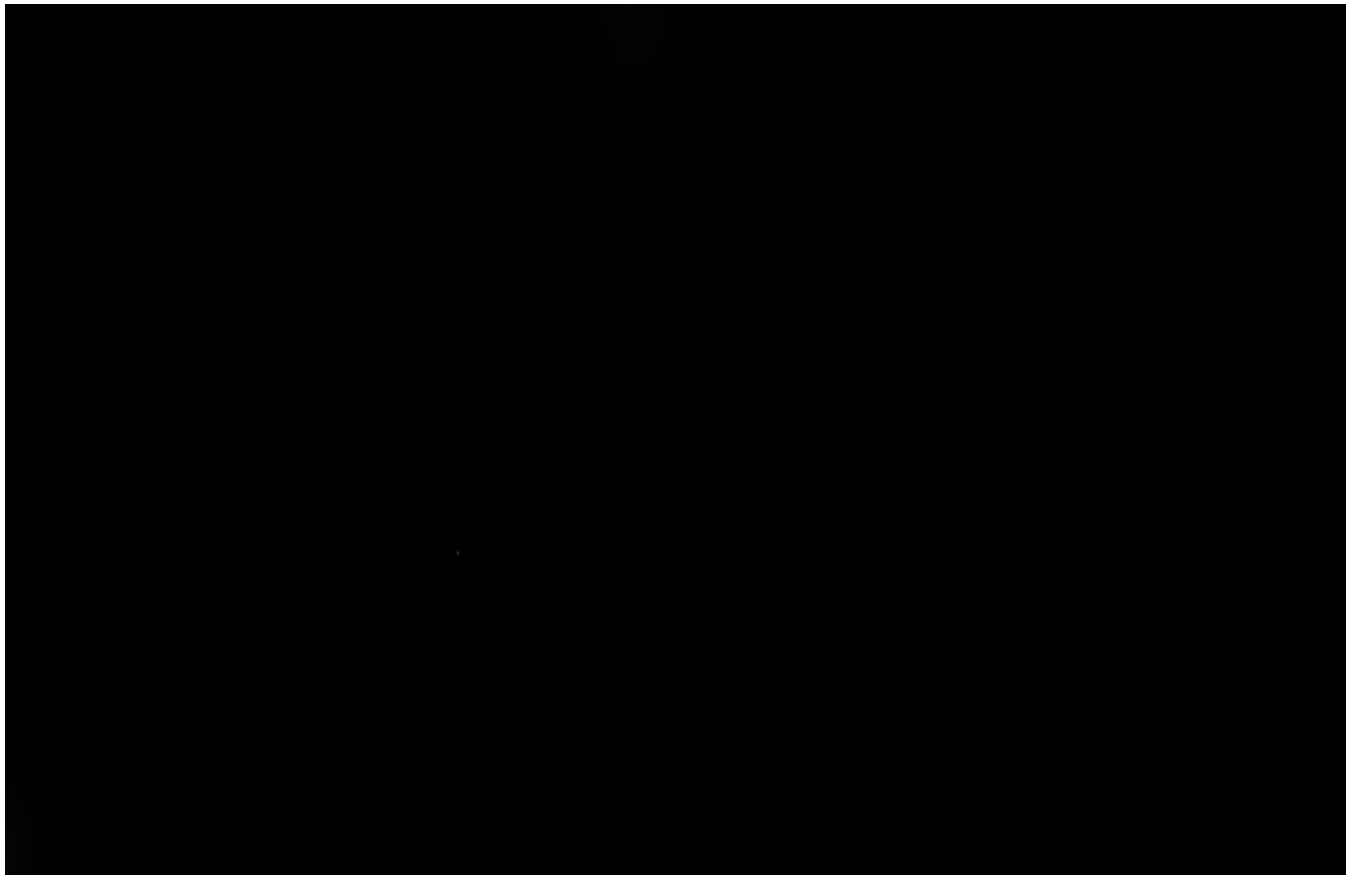

20 year
Long term O/IR lightcurve
of A0620-00
Charles Bailyn and Tolga Dincer
Yale University
(plus dozens of observers and students
over the decades)
R. Hynes 2000

A0620-00:
the “typical” low mass BH transient

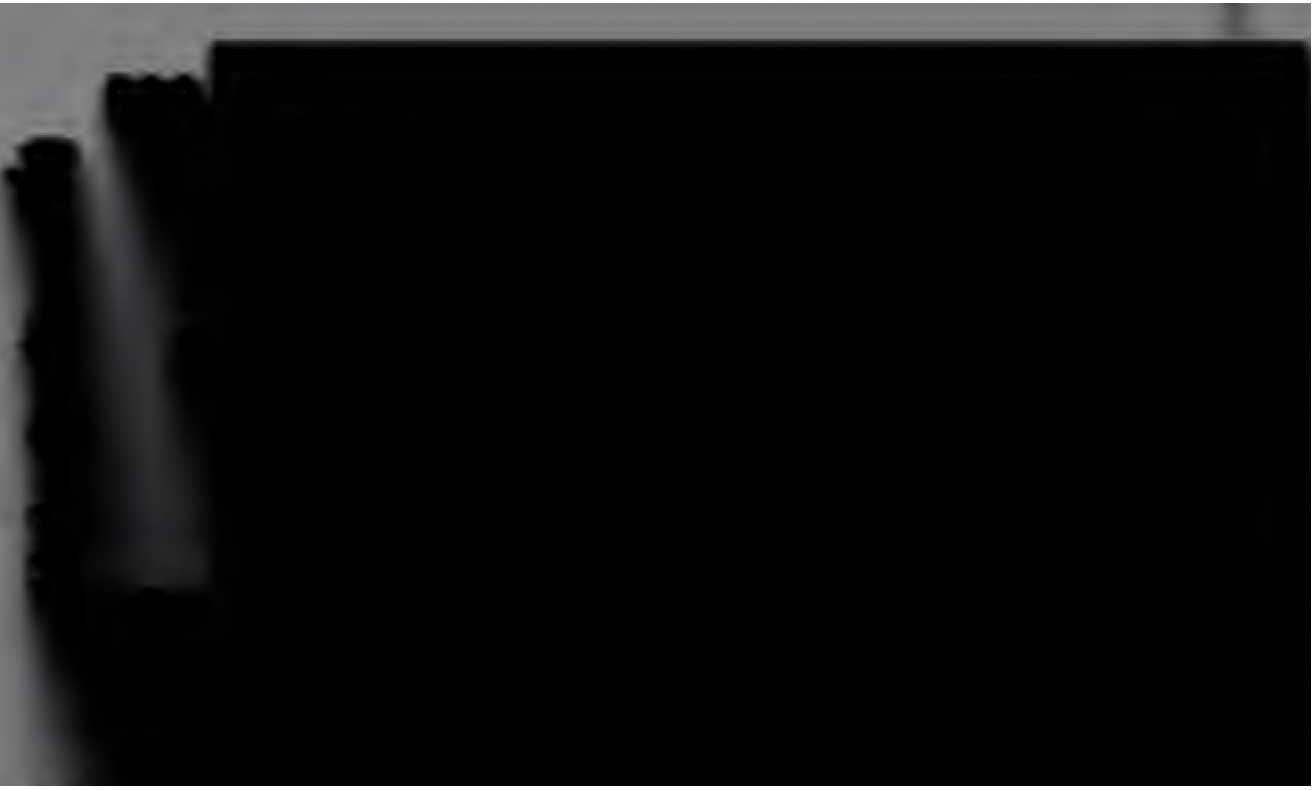


Elvis et al. 1975

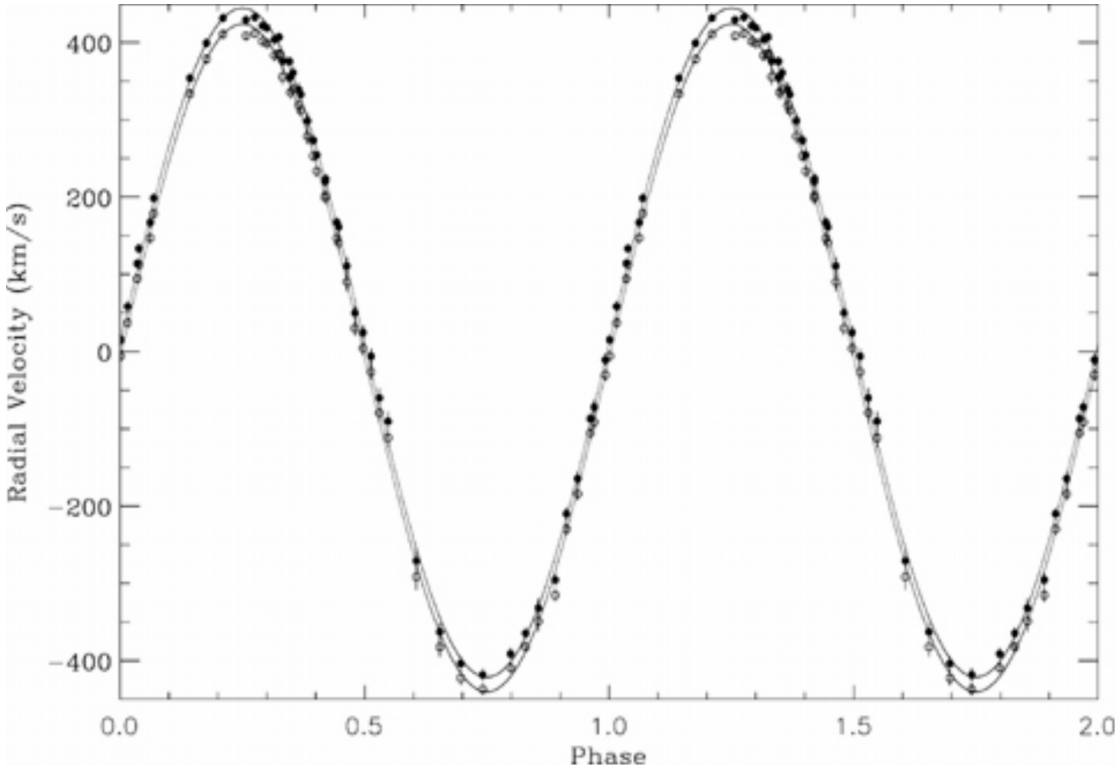


Matilski et al. 1976

A0620-00:
the “typical” low mass BH transient



McClintock & Remillard 1986



Neilsen, Steeghs & Vrtilek 2008

A0620-00:
the “typical” low mass BH transient

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

A0620-00

P = 7.7…. hours

K = 425 km/s

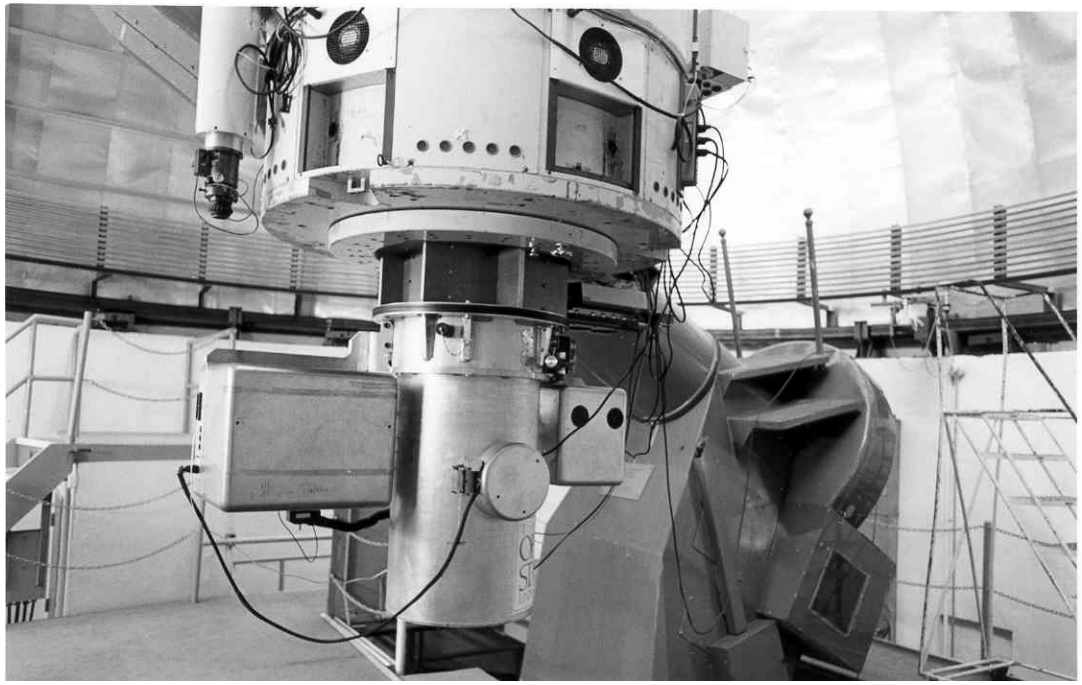
f = 3.1M_o

Disk Instability Mechanism (DIM)

- Key to the demographics and evolution of transient LMXBs.
- Quiescence: $\dot{M}_{disk} < \dot{M}_{*}$ 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 $\dot{M}_{disk}$.
- Outburst: Disk ”flushes” onto the accreting object.
- Complexities
  - Irradiation
  - Non-disk accretion flows
  - Propagation of heating and cooling flows

SMARTS ANDICAM Observations

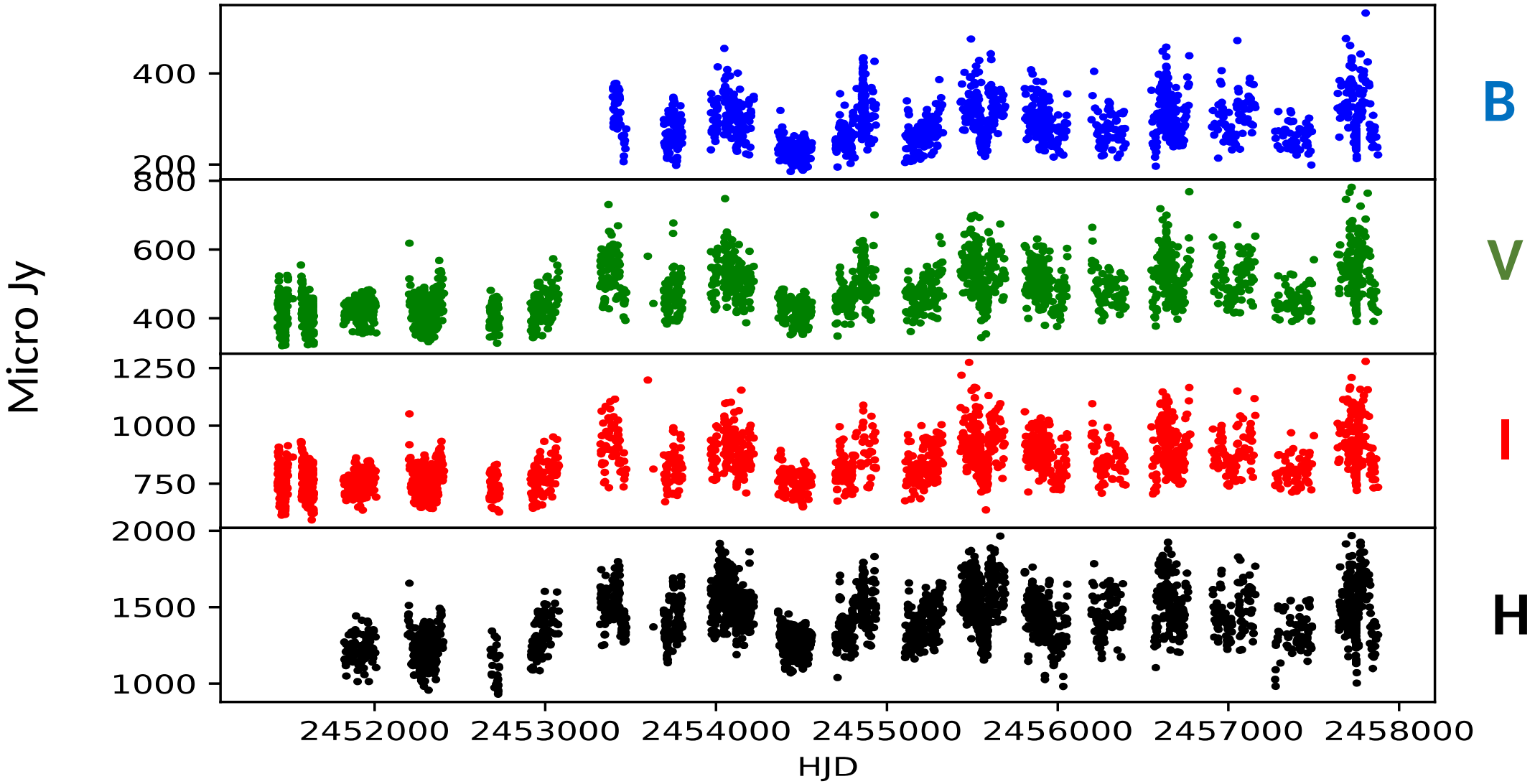
- Optical+IR imager
- Optimized for queue observing
- 1998-2002 on Yale 1m
- 2003-present on 2MASS 1.3m

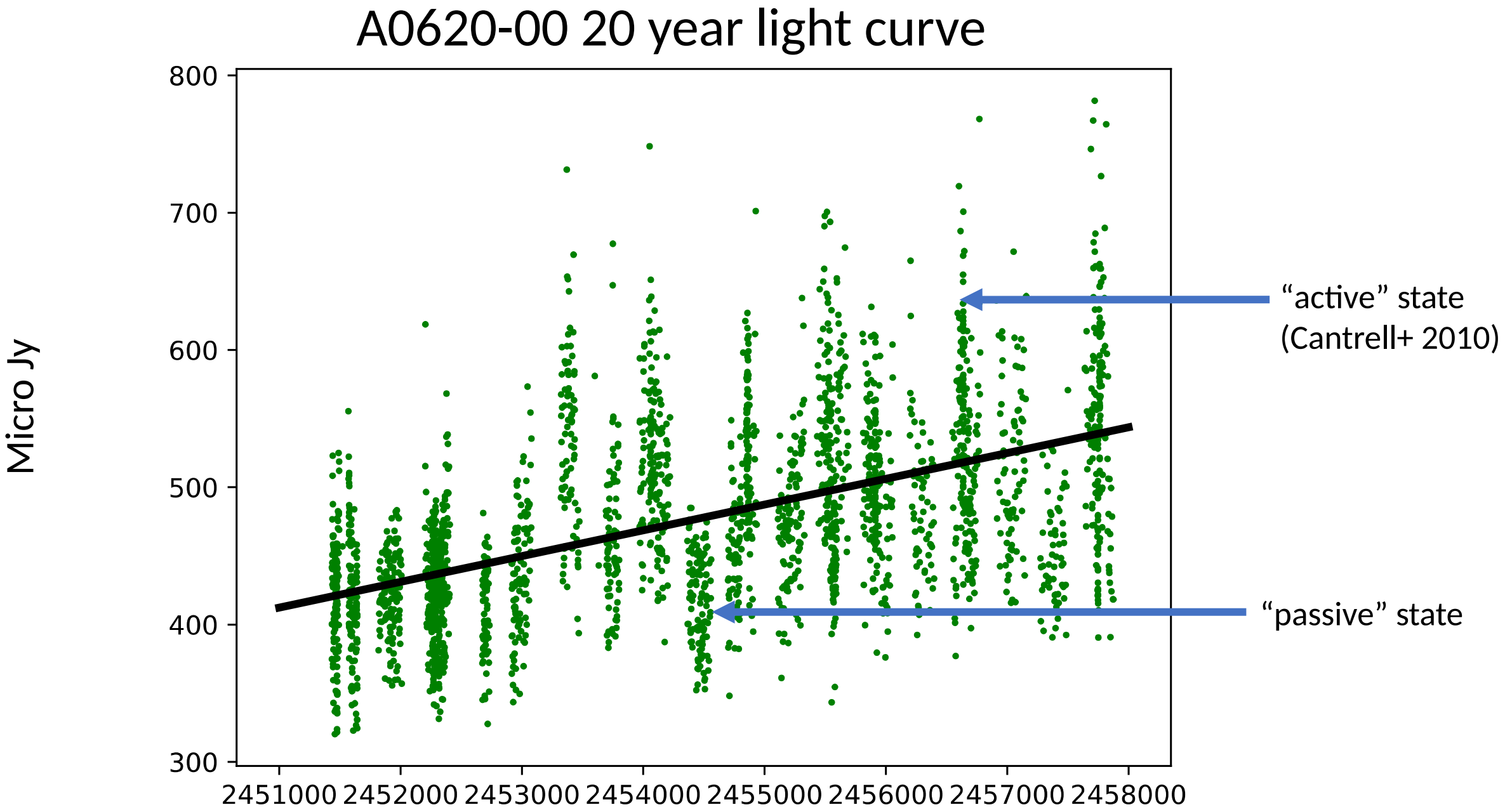


LMXB Observations

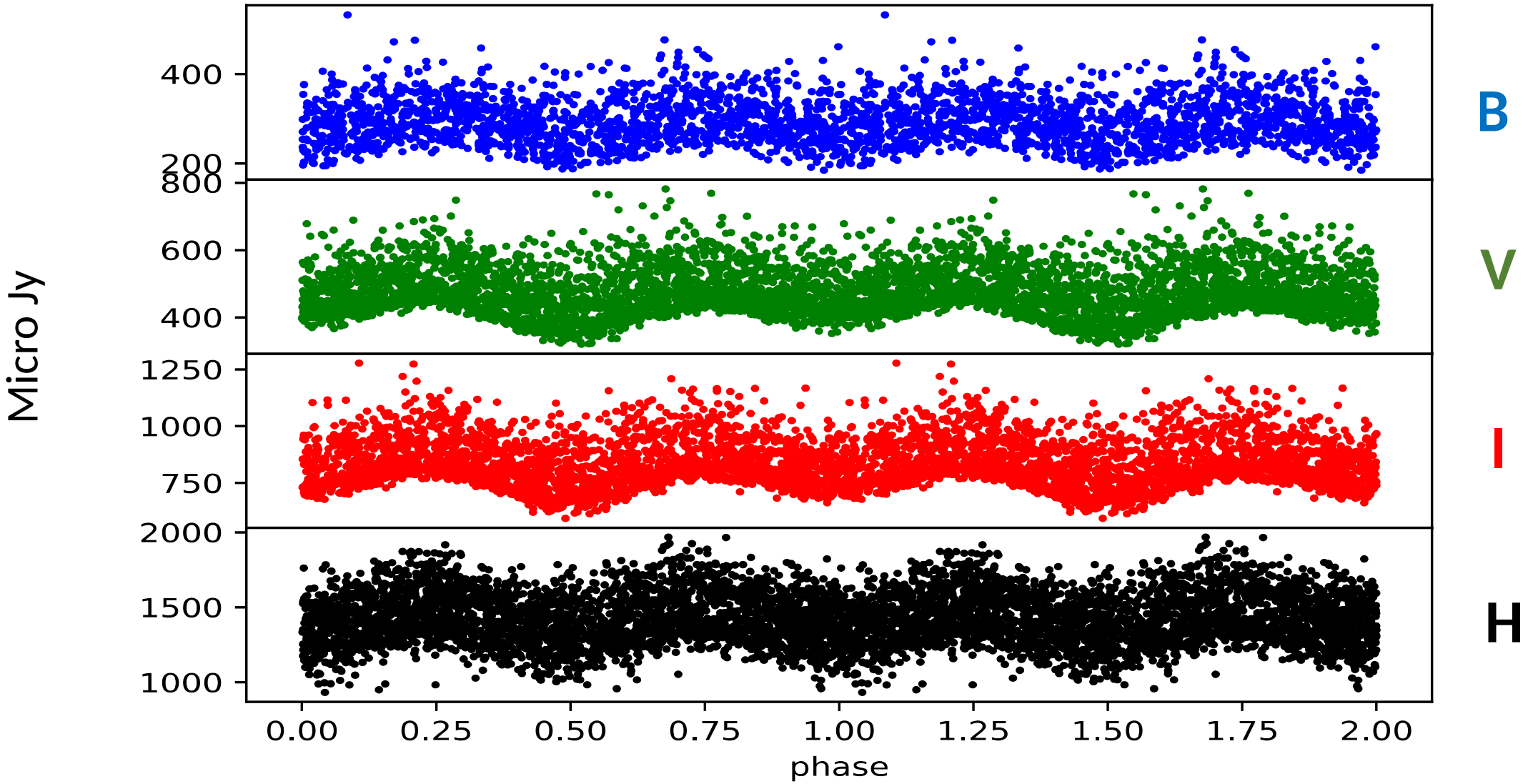
- Near nightly observations:
  - A0620-00
  - GRO J1655-40
  - GX 339-4 - Buxton+ 2012
  - GRS 1915+105 (K only) – Neal+ 2007
  - 4U1543-47
  - SAX 1819-2525 (V4641 Sgr) - MacDonald+ 2014
  - GRS 1124-68 (Nova Mus ‘91) – Wu+ 2016
  - Neutron stars: Aql X-1, Cen X-4

A0620-00 20 year light curve

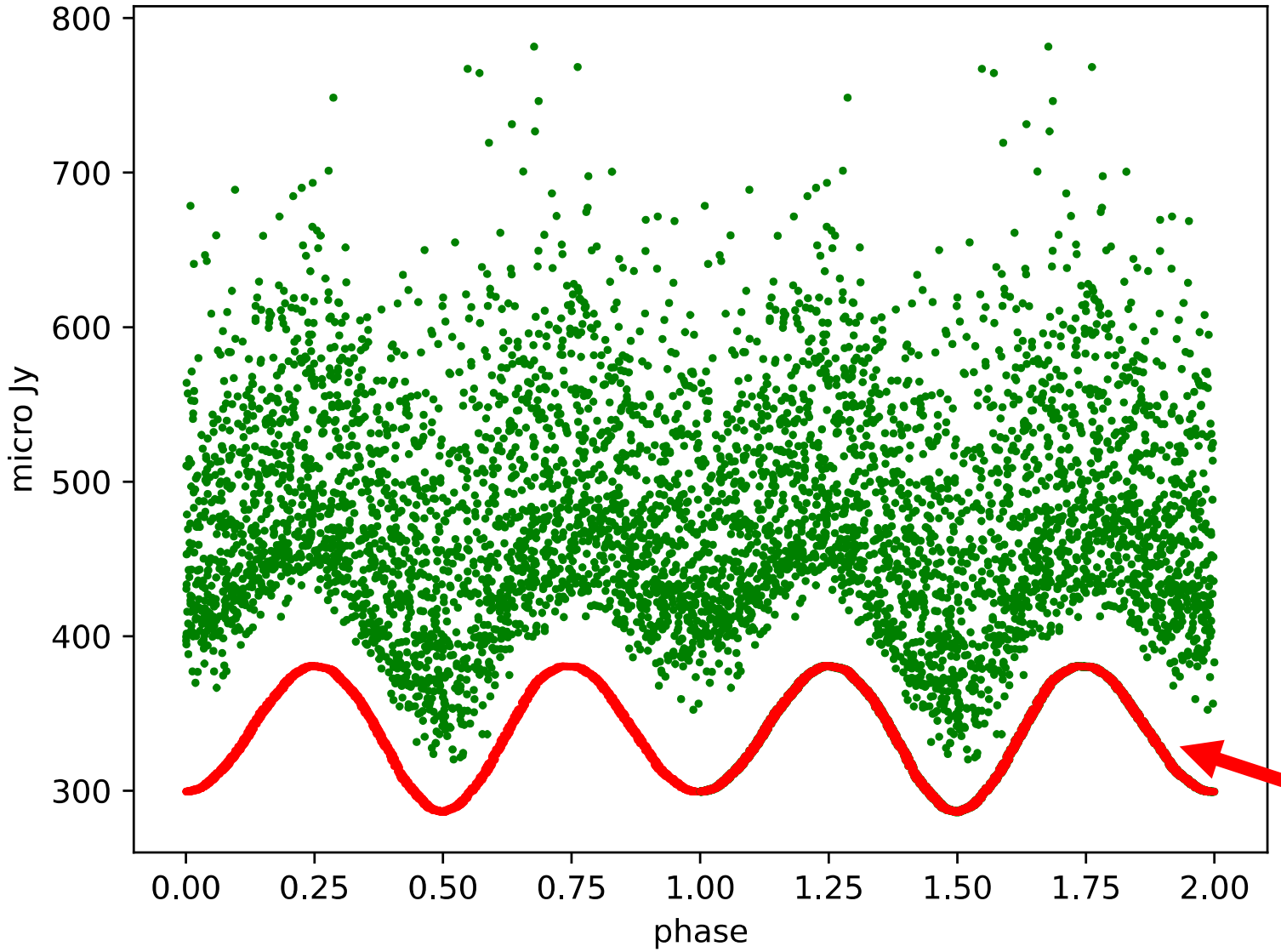


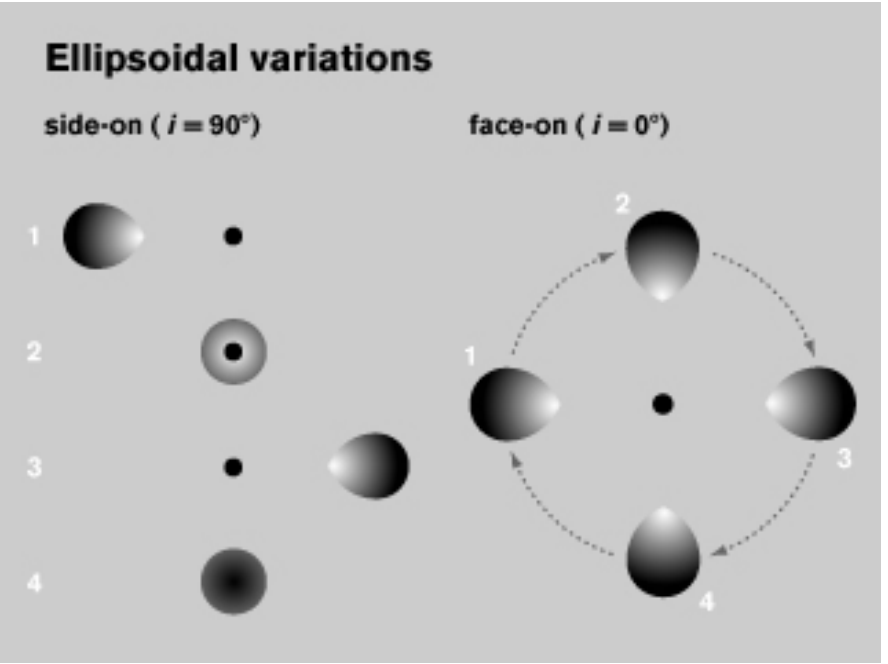

A0620-00 20 year light curve
Micro Jy
800
700
600
500
400
300
2451000
2452000
2453000
2454000
2455000
2456000
2457000
2458000
“active” state
(Cantrell+ 2010)
“passive” state

A0620-00 20 year folded light curve



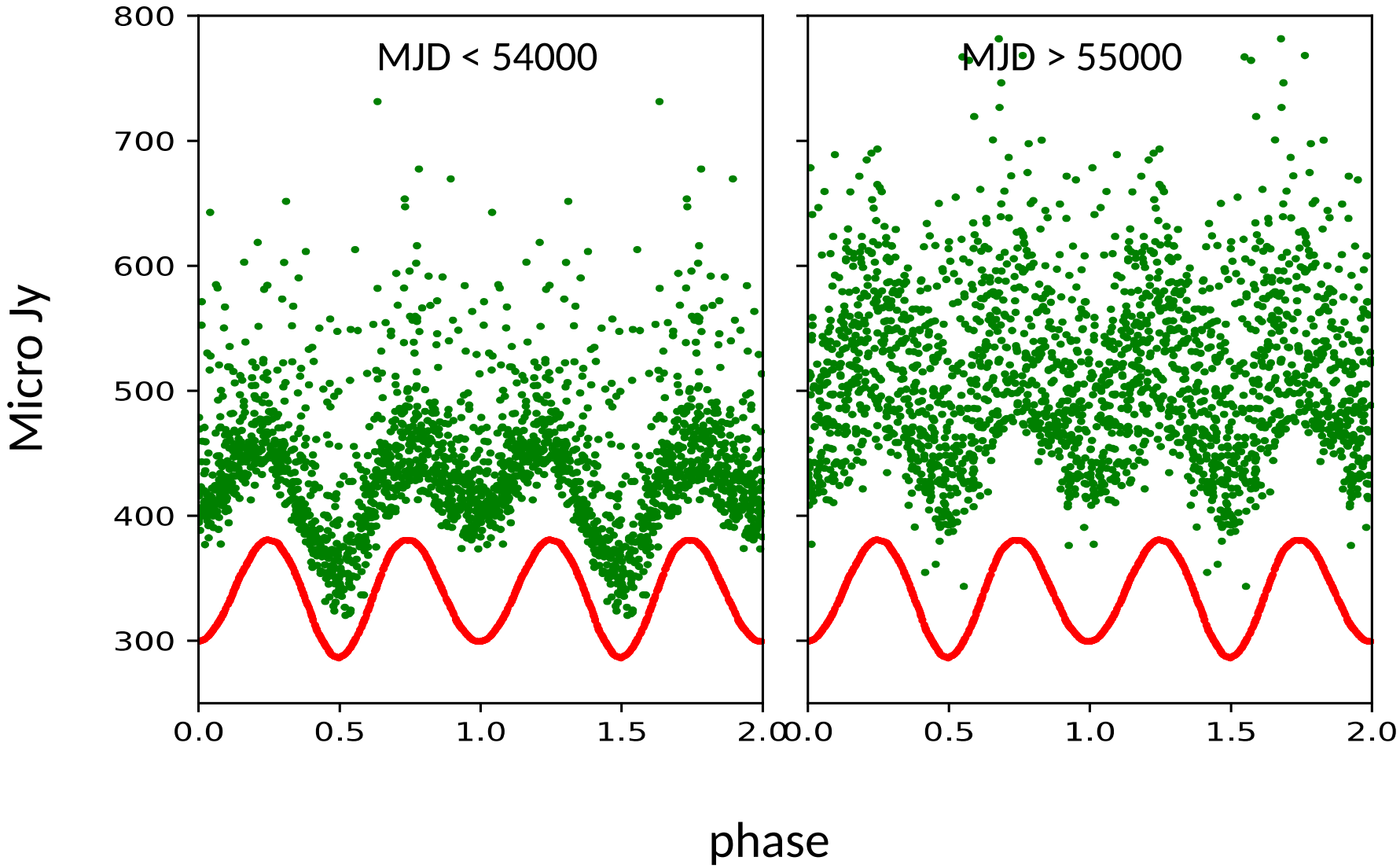
A0620-00 20 year folded light curve



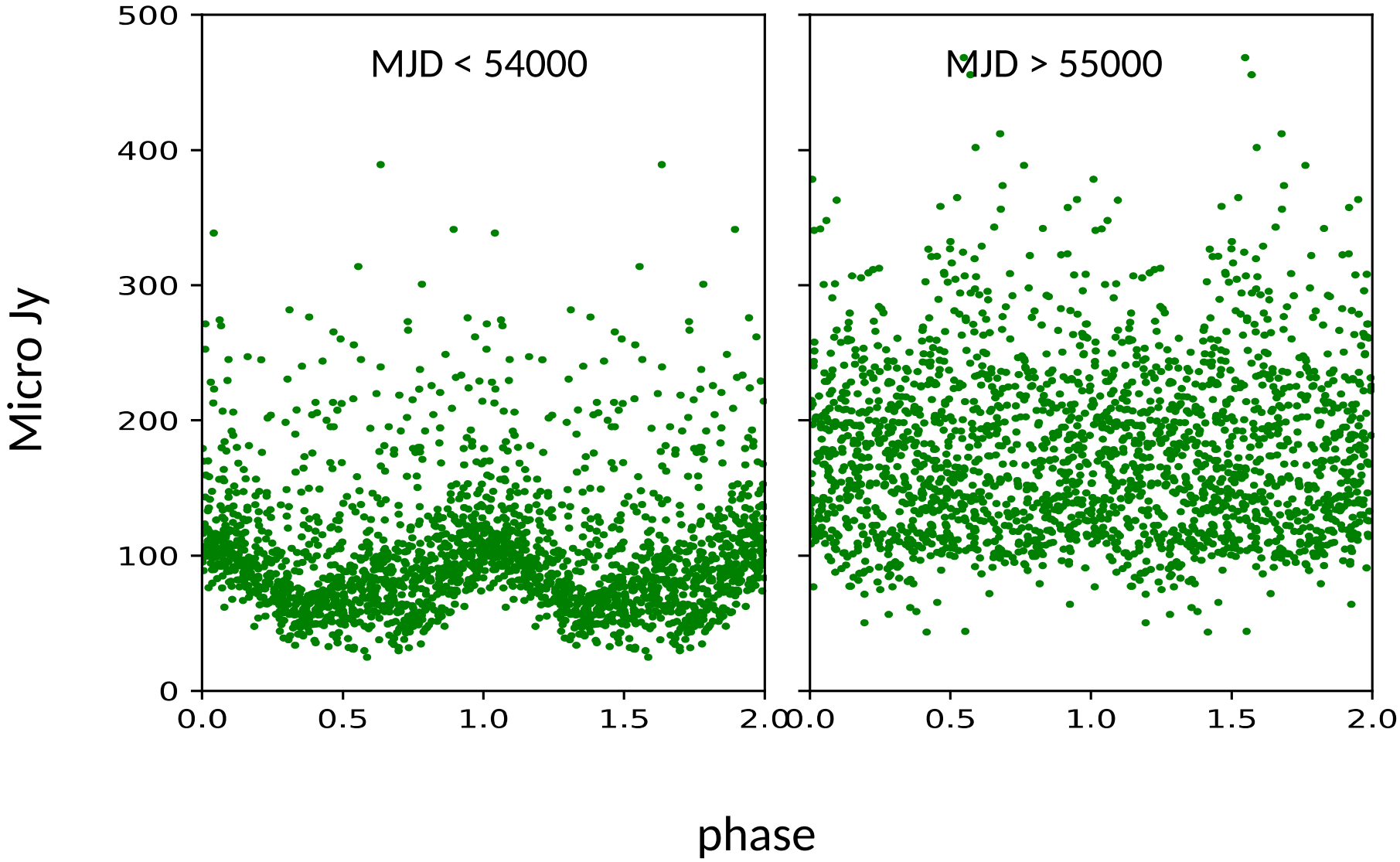


Pure ellipsoidal model
Cantrell et al. 2010

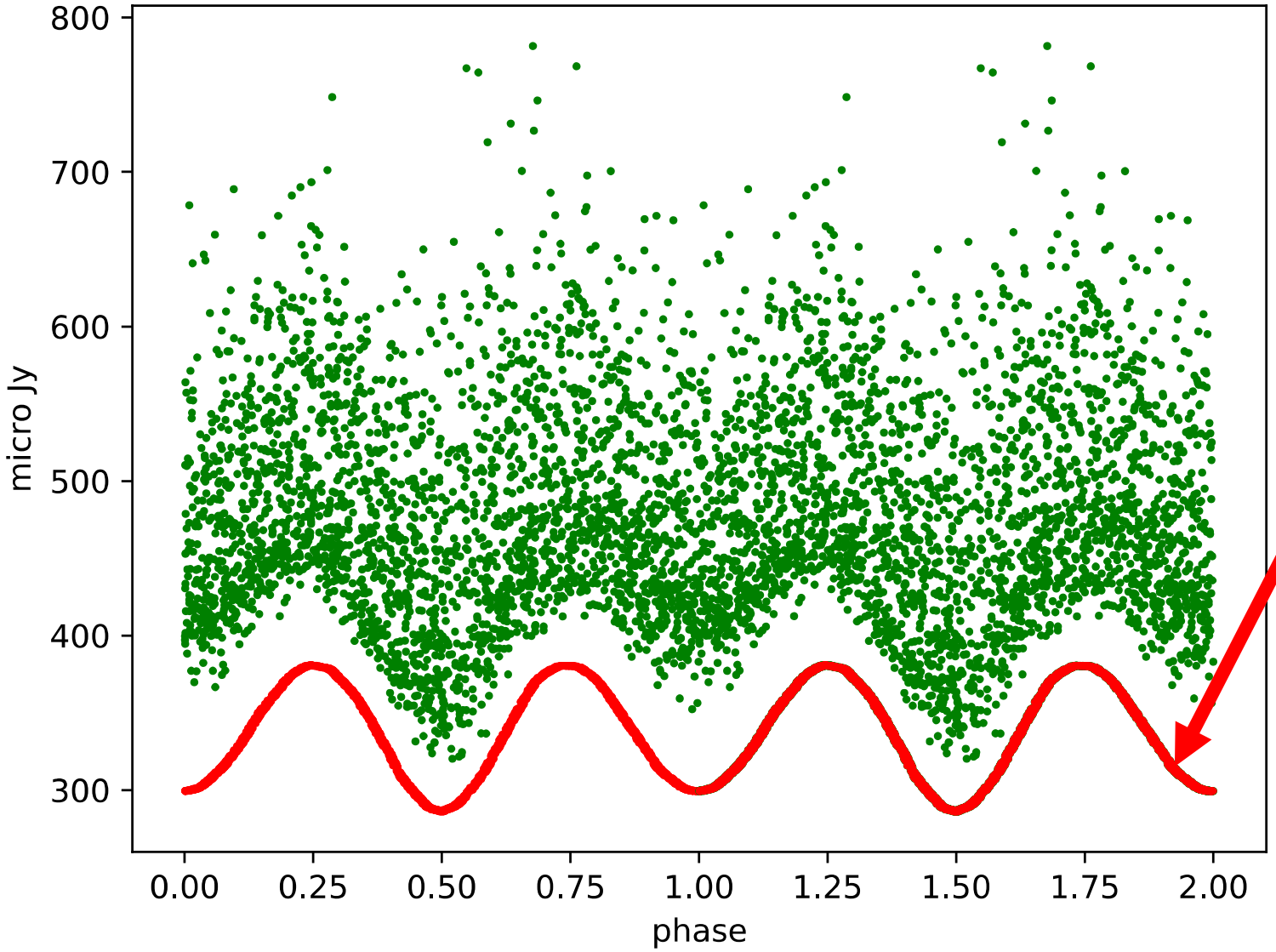
A0620-00 20 year folded light curve: Total flux



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

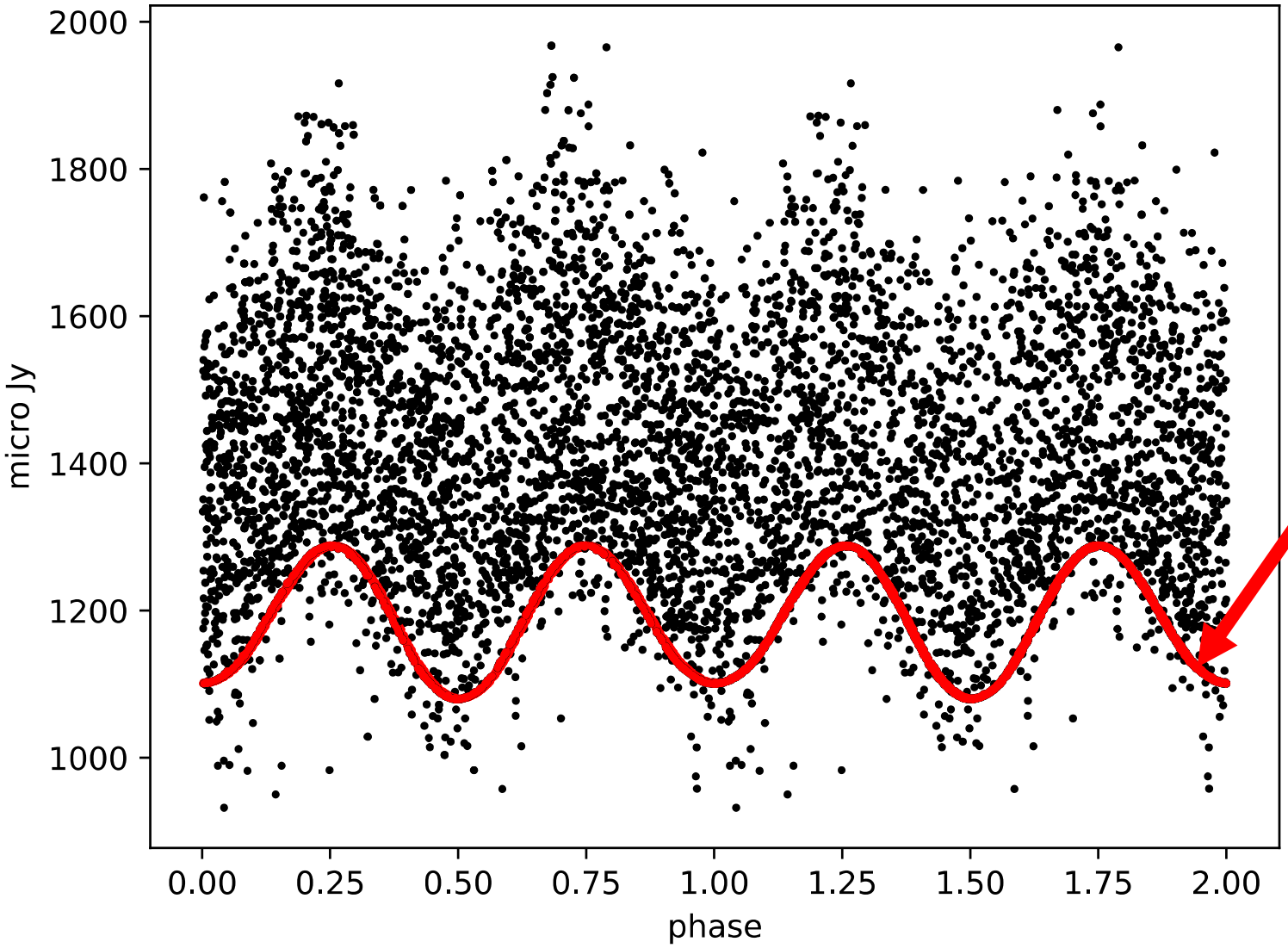


A0620-00 20 year folded light curve



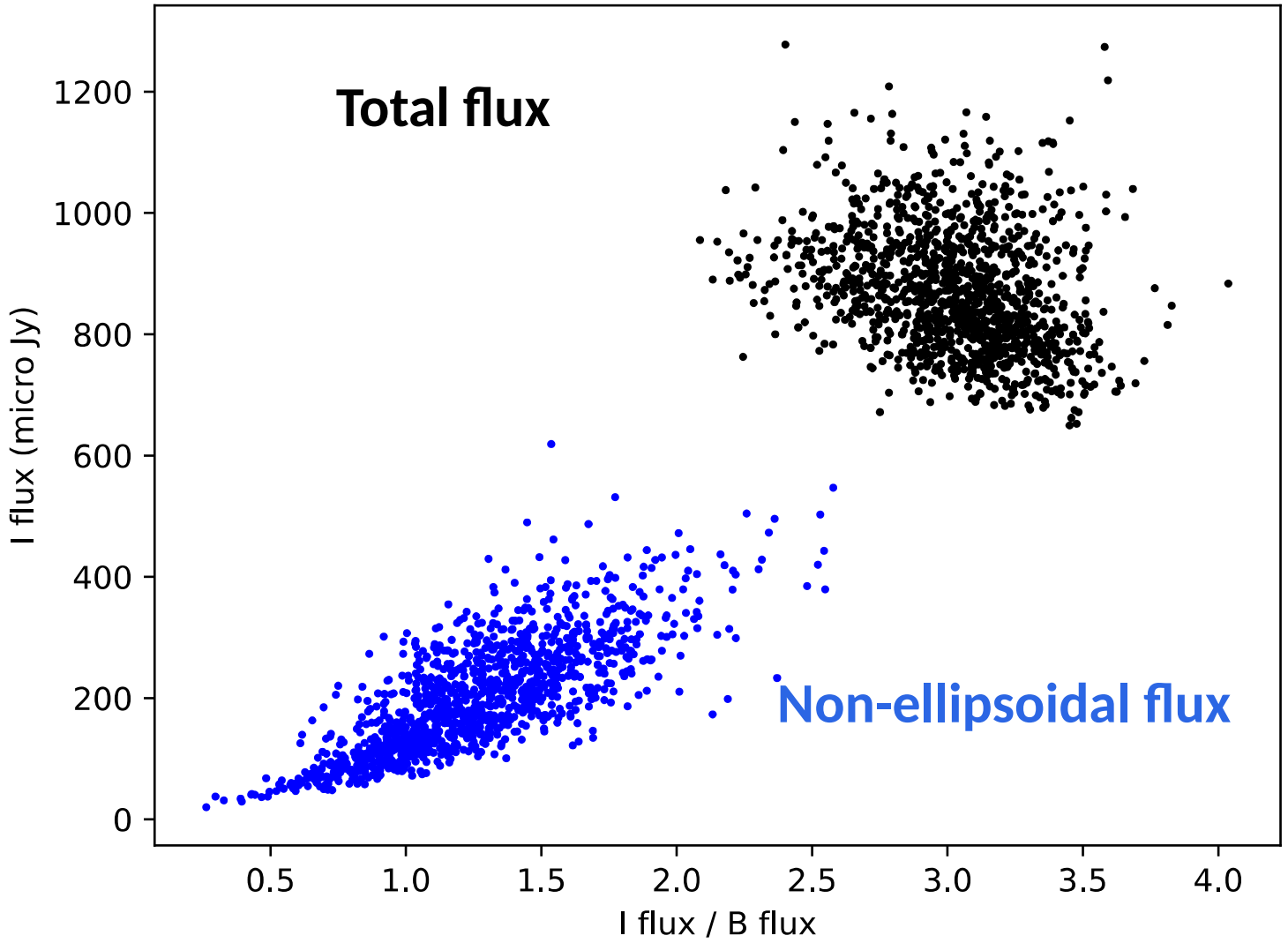
Pure ellipsoidal model
Cantrell et al. 2010

A0620-00 20 year folded light curve



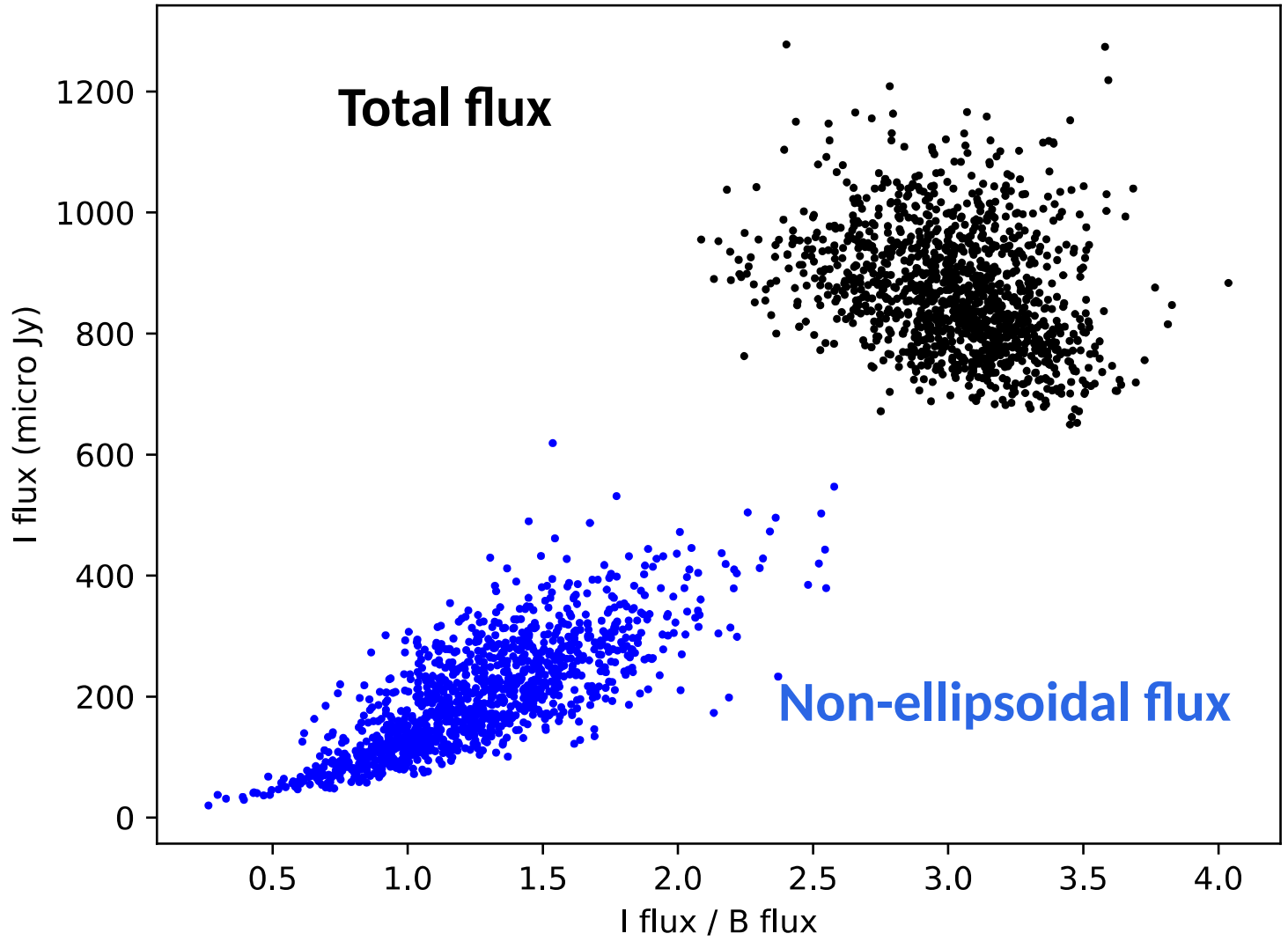
Pure ellipsoidal model
Cantrell et al. 2010

A0620-00 color-brightness



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

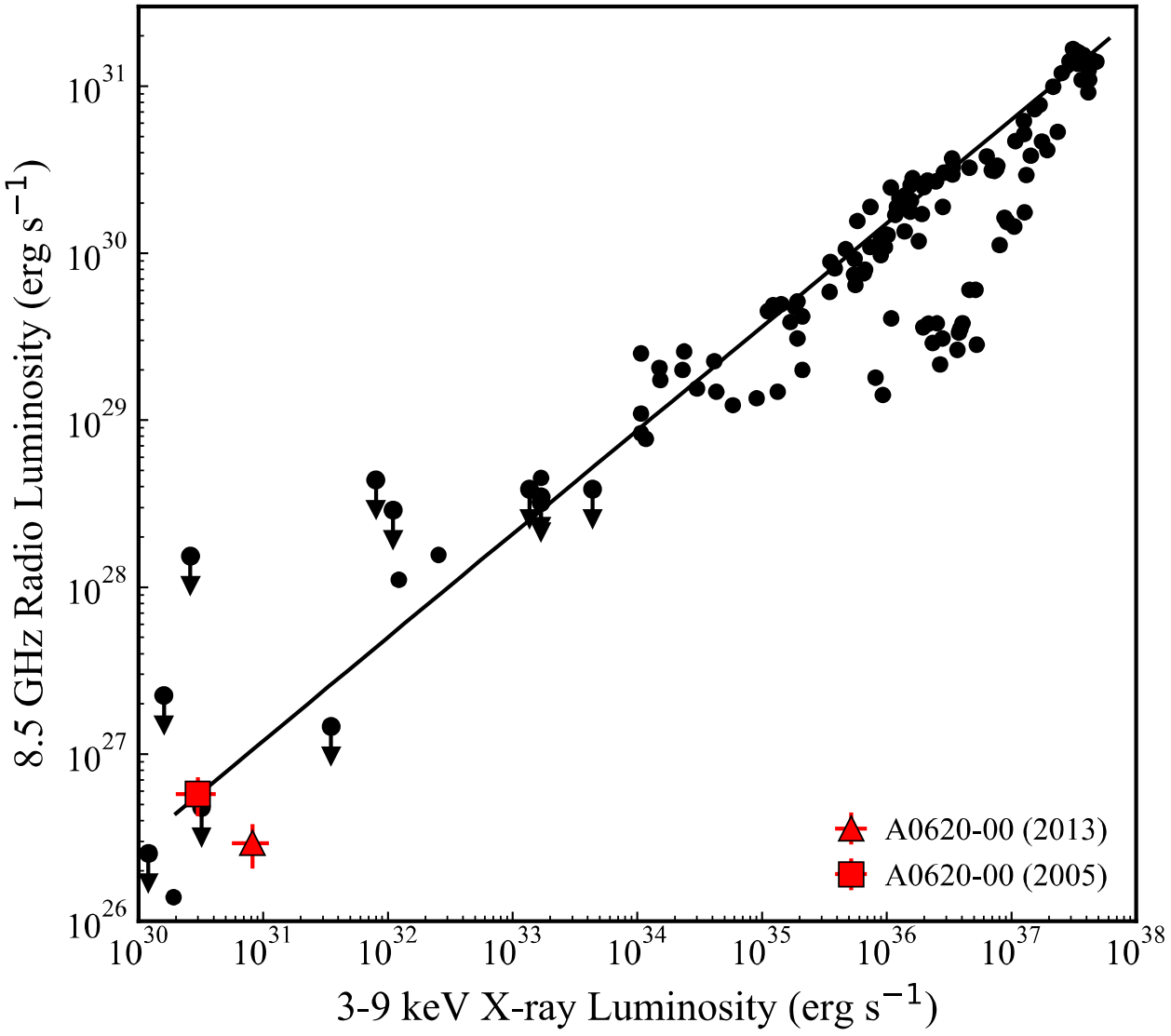
A0620-00 color-brightness



- 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



Dincer+ 2018

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