Unraveling the Multi-Timescale Variability of the Magnetic Cataclysmic Variable

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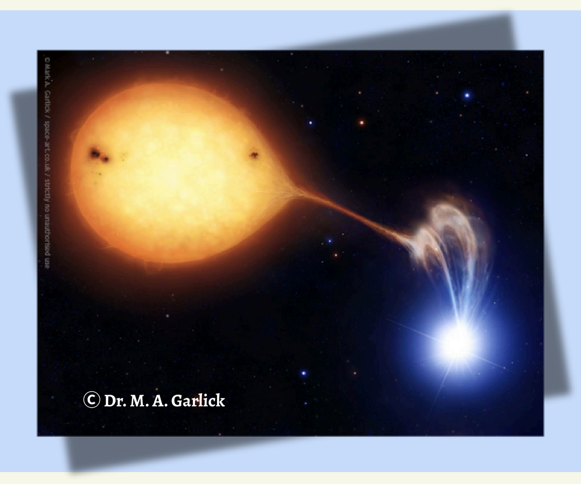
We present a multi-epoch X-ray and optical study of the polar-type cataclysmic variable candidate CXOU J204734.8+300105 (J204734). Analysis of Chandra and XMM-Newton data reveals conflicting timing signatures: a ~6000 s period with a deep eclipse in 2000, but a dominant ~2000 s period without eclipses in 2017. Simultaneous optical data consistently show the ~6000 s period. Spectral analysis indicates a hot (~12 keV) thermal plasma with variable partial absorption and strong, ionized Iron emission lines. These results point to a dynamic accretion geometry, challenging the simple eclipsing polar classification and suggesting a system with a shifting accretion state.

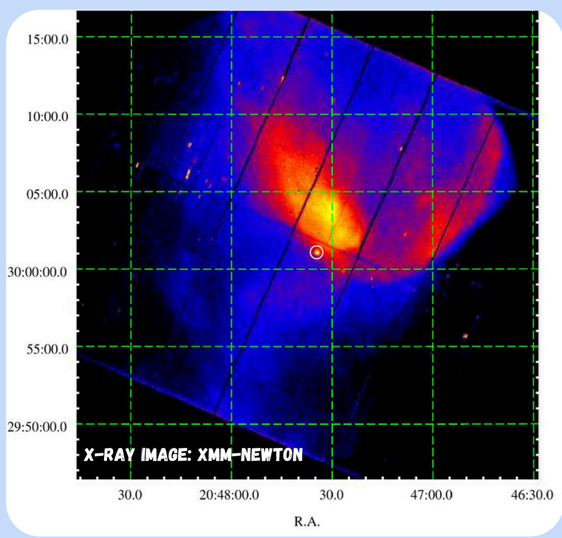


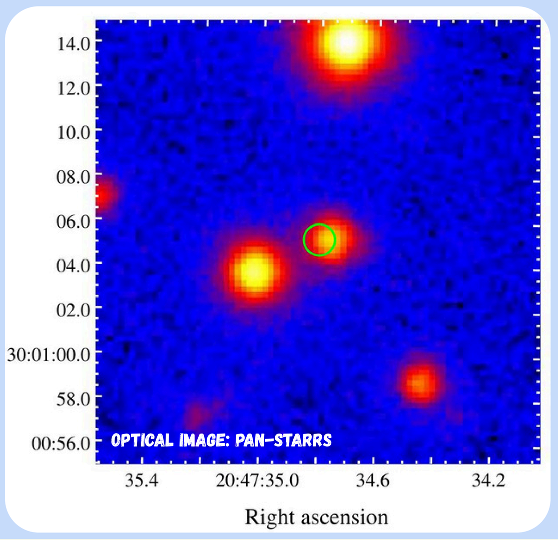
1. INTRODUCTION

- Cataclysmic Variables (CVs) are close binary systems where a white dwarf accretes matter from a companion star.
- Magnetic CVs: The white dwarf's strong magnetic field (≥10^6 G) channels accretion onto its poles.
- Polars (AM Her-type): No accretion disk; white dwarf spin is synchronized with the orbital period.
- J204734 was initially classified as an eclipsing polar based on Chandra data (Israel et al. 2016).
- Our Goal: To investigate the source's complex and variable nature using archival data from Chandra, XMM-Newton, and optical surveys (ZTF, OM, etc.).

2. OBSERVATIONS

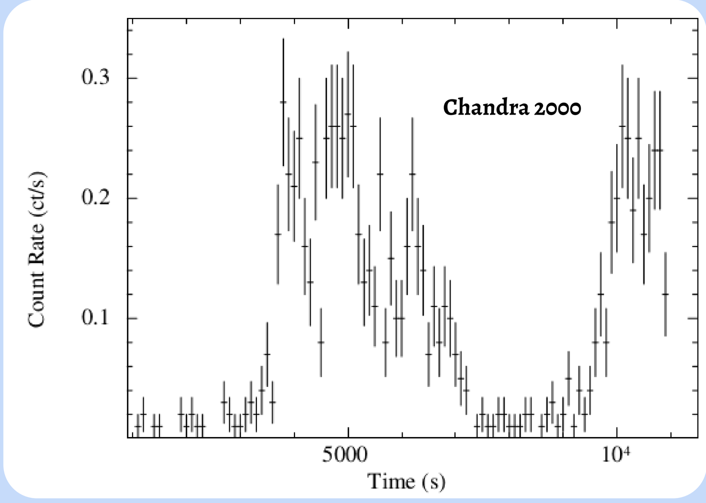
We analyzed data from three key X-ray observations (Chandra - 2000 and XMM-Newton - 2002 & 2017) and multiple optical archives (ZTF, XMM-OM).





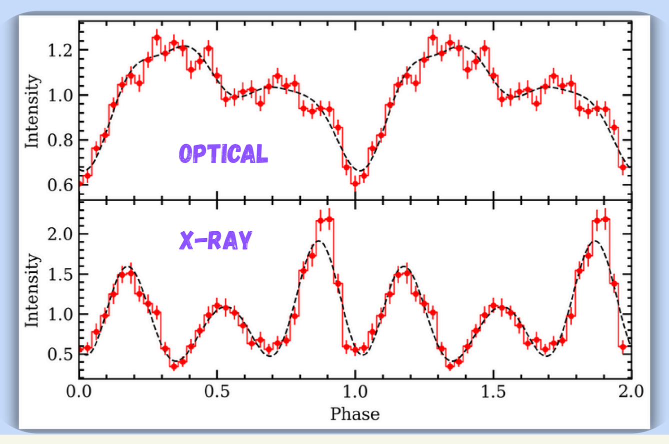
3. LIGHT CURVE

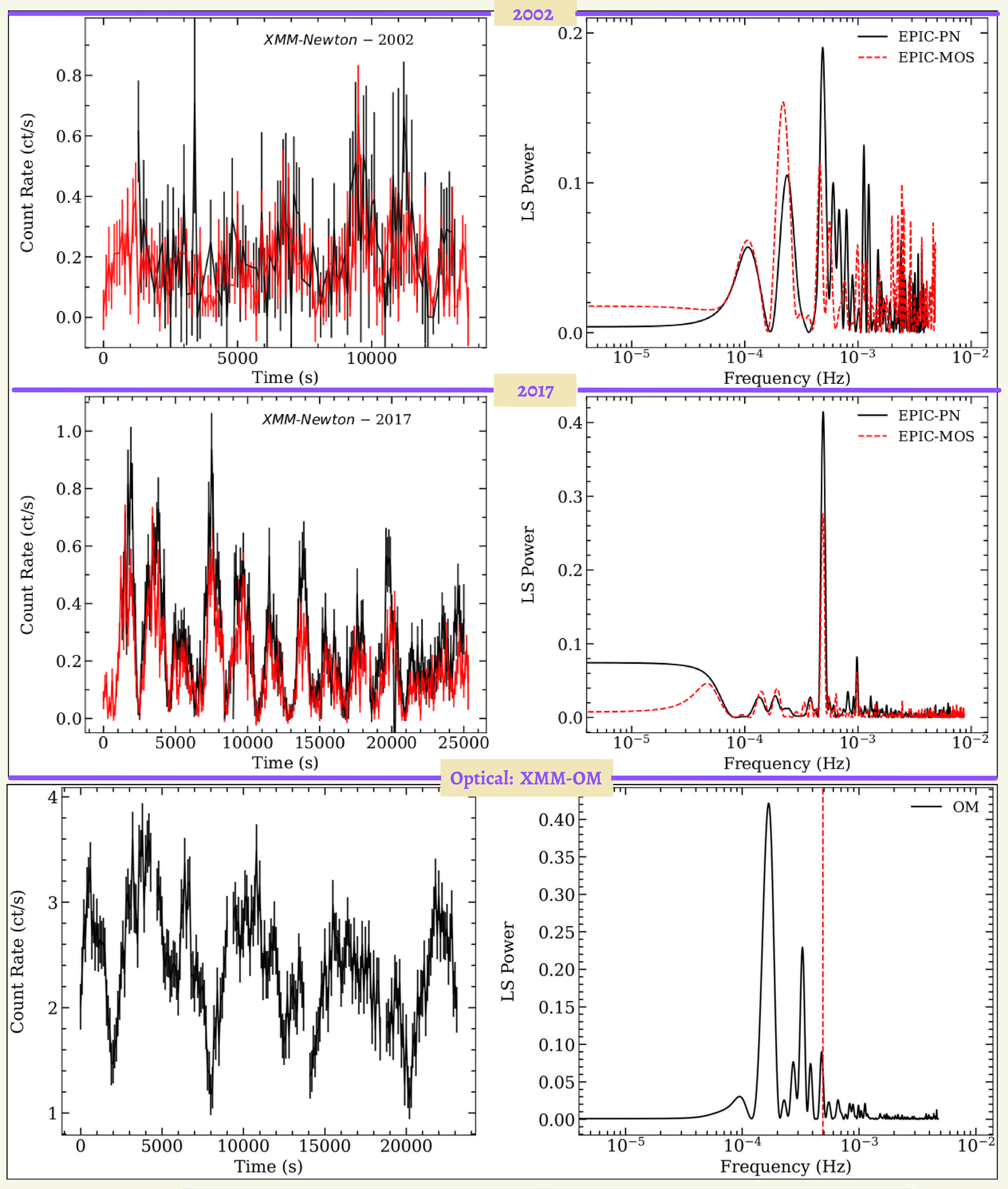
Chandra Light Curve (yr 2000): X-ray eclipse
Period ~6000 s; Eclipse duration ~2000 s

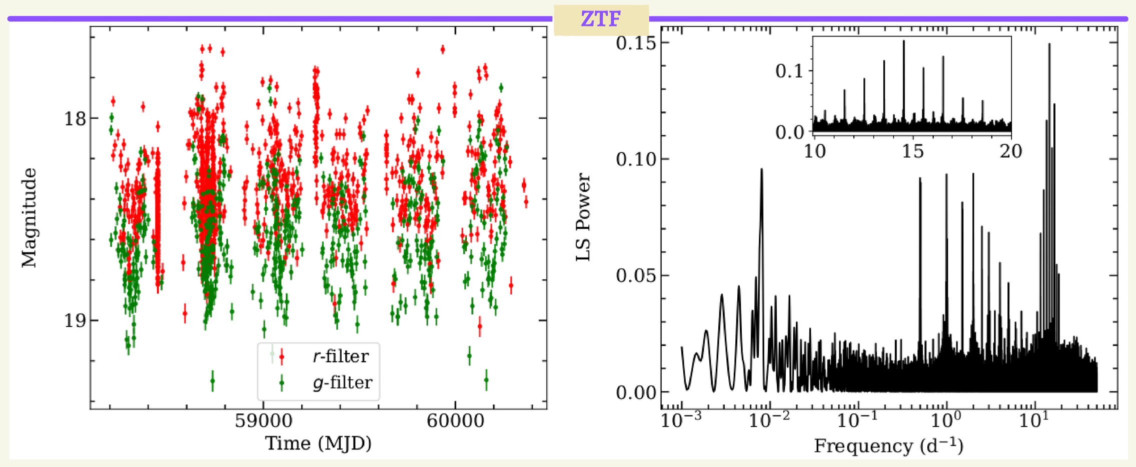


4. TIMING ANALYSIS

1. **Conflicting X-ray Periodicities**
   - Chandra (2000): Shows a clear ~6000 s period with a deep, ~2000 s eclipse-like feature.
   - XMM-Newton (2017): Reveals a strong, coherent 2027 (3) s period, but no eclipse. The 2002 data show a marginal signal at the same period.
2. **Consistent Optical Period**
   - The XMM-Newton Optical Monitor (OM, 2017) and long-term ZTF data both show a stable 5948 s period.
   - The X-ray ~2000 s period appears as a third harmonic in the OM data.

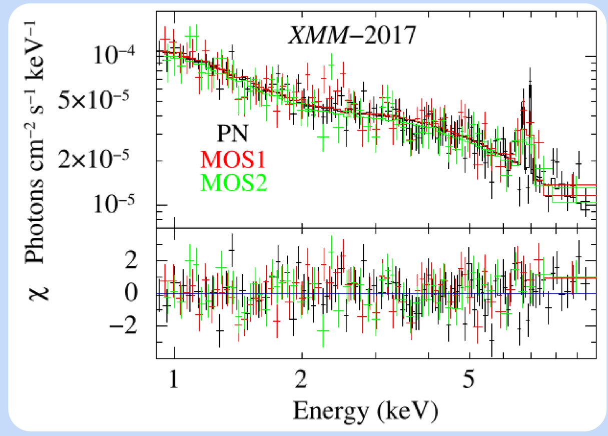




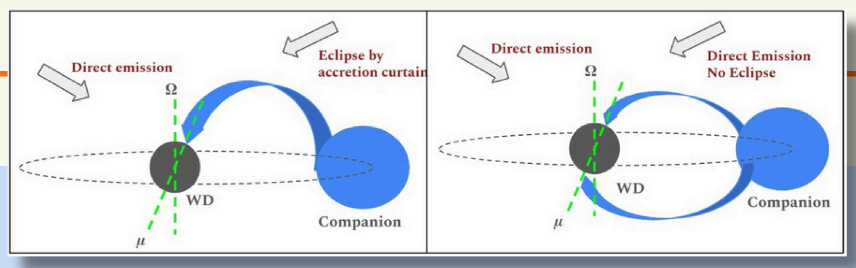


5. SPECTRAL ANALYSIS

- The 2017 spectrum is best fit by a hot thermal plasma (APEC, kT ~12 keV) subject to variable local partial absorption.
- Strong He-like (6.7 keV) and H-like (7.0 keV) Iron Kα emission lines with EQW of 144 and 122 eV, respectively, indicating ionized accretion flow.



6. DISCUSSION & INTERPRETATION



- The ~6000 s optical period is the system's fundamental orbital period.
- The ~2000 s X-ray period is the third harmonic, suggesting structured accretion onto multiple magnetic poles.
- The disappearance of the eclipse and change in dominant period between 2000 and 2017 indicate a dramatic shift in accretion geometry. Similar to AM Her (Mason, 1985).
- Chandra (2000): Likely a "low state" with accretion onto one pole, causing self-eclipse.
- XMM-Newton (2017): A "high state" with accretion onto multiple poles, producing a complex 3-peaked light curve.
- The spectrum confirms a hot accretion column and the presence of ionized material.
- Estimated X-ray luminosity $L_X \sim 10^{33}$ erg/s is typical for magnetic CVs.

7. CONCLUSIONS

- J204734 is a highly variable magnetic CV whose behavior does not fit a simple, stable eclipsing polar model.
- The observed changes in periodicity and light curve morphology are driven by evolving accretion flow and geometry (Ramsay et al. 2004).
- The consistent presence of ionized iron lines points to ongoing, structured accretion.
- Future work requires dedicated multiwavelength monitoring to track state changes and further constrain the magnetic accretion physics e.g., cyclotron emission.

Reference:

- Israel et al. 2016, MNRAS, 462, 4371
- Mason, 1985, SSRv, 40, 99
- Ramsay et al. 2004, MNRAS, 350, 1373

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