Analysis of Binary QX Cas

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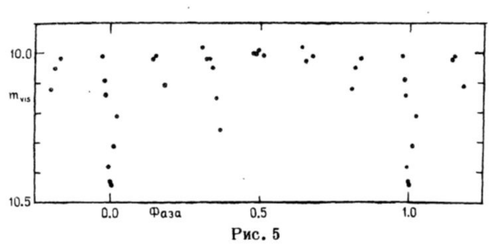
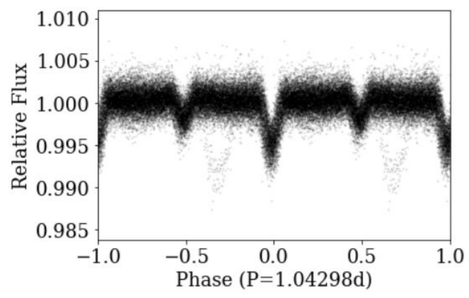
Github

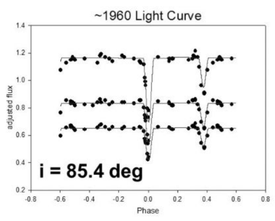
Video Demo

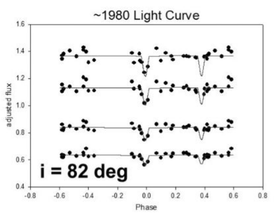
Overview

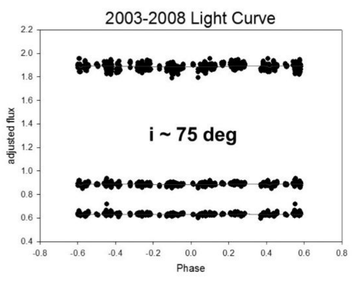
- QX Cas is a **binary** star system located in the constellation of **Cassiopeia**
- It **stopped eclipsing**, then **started up again!**
- It has a **different** period!
- **Three** unique periodic signals from QX Cas! (only 2 stars?)

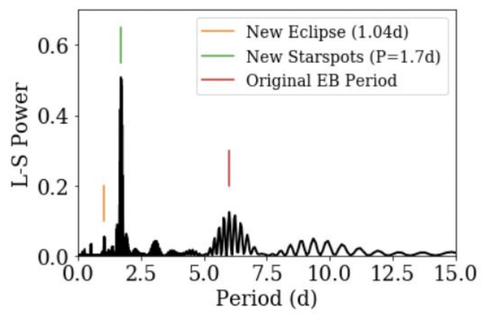






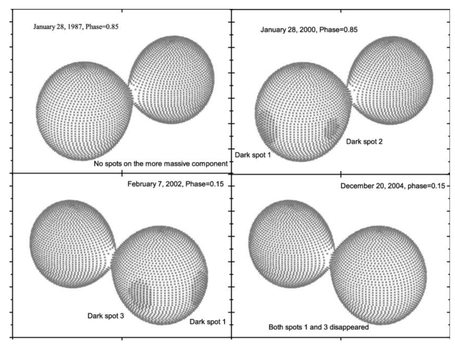


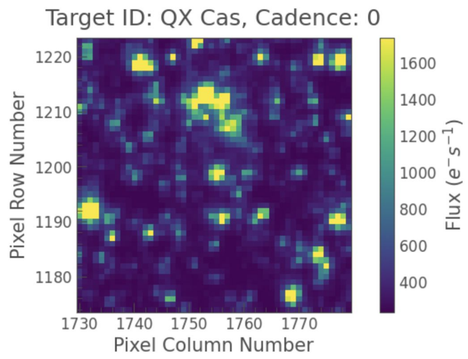


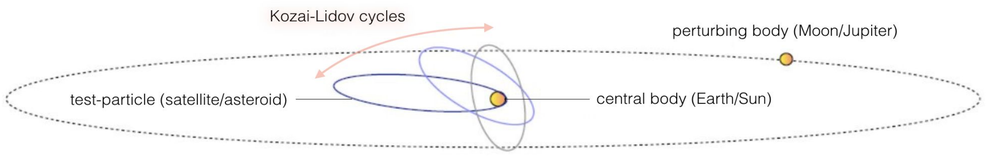


Why?

- **Cannibalism**?
- 'Kissing' Sars?
- Star **behind** it?
- A **third body** influencing the system?







Tools used to analyze data

- PHysics Of Eclipsing BinariEs (PHOEBE)
- Lightkurve
- Python
- C++
- KEBLAT
- PlanetPlanet
- ELISa
- Binary Star Combined Solutions Package

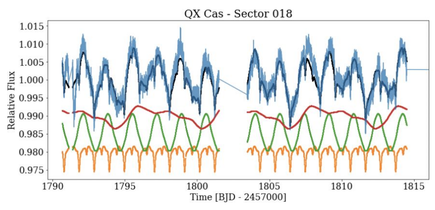
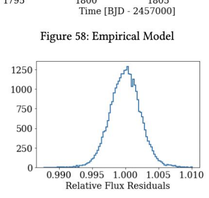


Figure 58: Empirical Model

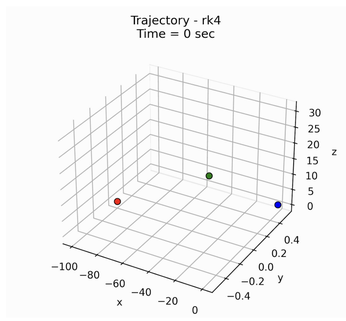


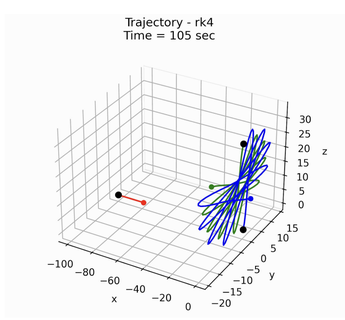
What did forward and inverse modeling say?

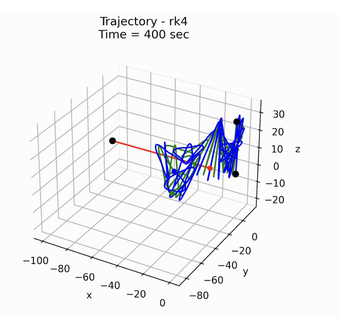
- It is **highly unlikely** that the star system is undergoing a fundamental change; a **third object** perturbing the system might have shifted the orbital plane!
- The **Kozai Cycle** is in effect here!

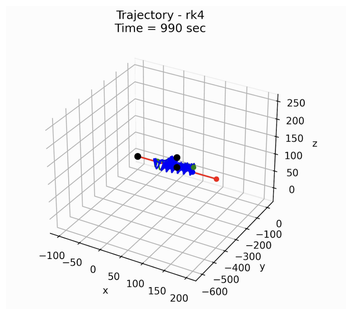
The solution?

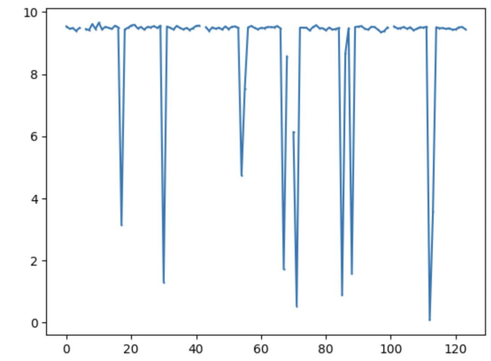
- A **three-body simulator** that generates light curves based on gravitational interactions!











Algorithms used

- MCMC
- Nelder-Mead Optimization
- Sigma-clipping
- Leapfrog
- Runge-Kutta 4
- Euler Integration
- Mandel-Algol Light Curve Synthesis
- Regression Vector Reduction

Eccentricity	0.22 ± 0.01
Longitude of periastron	45 ± 5 degrees
K1 sin(i)	125.8 ± 0.9 km/s
K2 sin(i)	144.8 ± 1.1 km/s
Vo	65.1 ± 0.5 km/s
Mass ratio	q=0.869 ± 0.013
M1	6.12 ± 0.56M⊙
M2	5.34 ± 0.56M⊙

Results,Conclusion,Future Scope

- The mass and orbital parameter estimates remain mostly constant despite analyzing datasets from different time periods.
- The QX Cas system does not show the 'classic' signs of contact binary systems or stellar overlap; the third signal must be coming from a very massive object pulsating behind the star system. (~10000-1000000M⊙)
- The 3-body simulator developed is **convenient**, **quick**, and **easy to use**, making it a convenient choice for an astronomer to get a quick idea at what might be happening in the system.
- Some future work on integrating non-gravitational effects (limb darkening, different atmospheres) can be included in the program.

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