Fascinating connection between data and event in cosmos *by Anna Köster*

My name is Anna Köster. I am a 17-year-old 11th grade student studying at the Kardinal-von-Galen Gymnasium Hiltrup in Germany. I used the telescope network of LCO to detect exoplanets in the binary star system CSS080502. I described and analysed my findings within a term paper (German "Facharbeit") titled "Methods of Detection of Exoplanets using the Example of the binary star system CSS080502".

My interest in STEM (in German: MINT for Mathematics, Informatics, Natural science, and Technology) developed throughout my school history. Because my school is a certificated MINT-EC school, I had the possibility to take part in study groups and compulsory optional subjects which helped strengthen my interest in physics, especially astrophysics. Therefore, in October of 2020, I took part in the MINT-EC-Camp "Astronomy 2.0" of the local educational initiative AiM (Astronomy and internet in Münster) supervised by Paul Breitenstein. During the course of the camp, the participants learned about the work of an astrophysicist and used the Faulkes Telescope South in Siding Springs/Australia to confirm "Near-Earth-Objects" (NEOs). Because of this camp, one and a half years later I decided to write my mandatory term paper in school about anastrophysical topic.

In this term paper, I explain different detection methods of exoplanets and use the timing method to try to detect an exoplanet in the binary star system CSS080502. To start with, I received 70 existing eclipse times of the system CSS080502 with these I calculated the expected approximate times of future eclipses. The measured and the calculated times of the eclipses of CSS080502 showed a quasi-sinusoidal offset from a linear fit to all eclipse times.

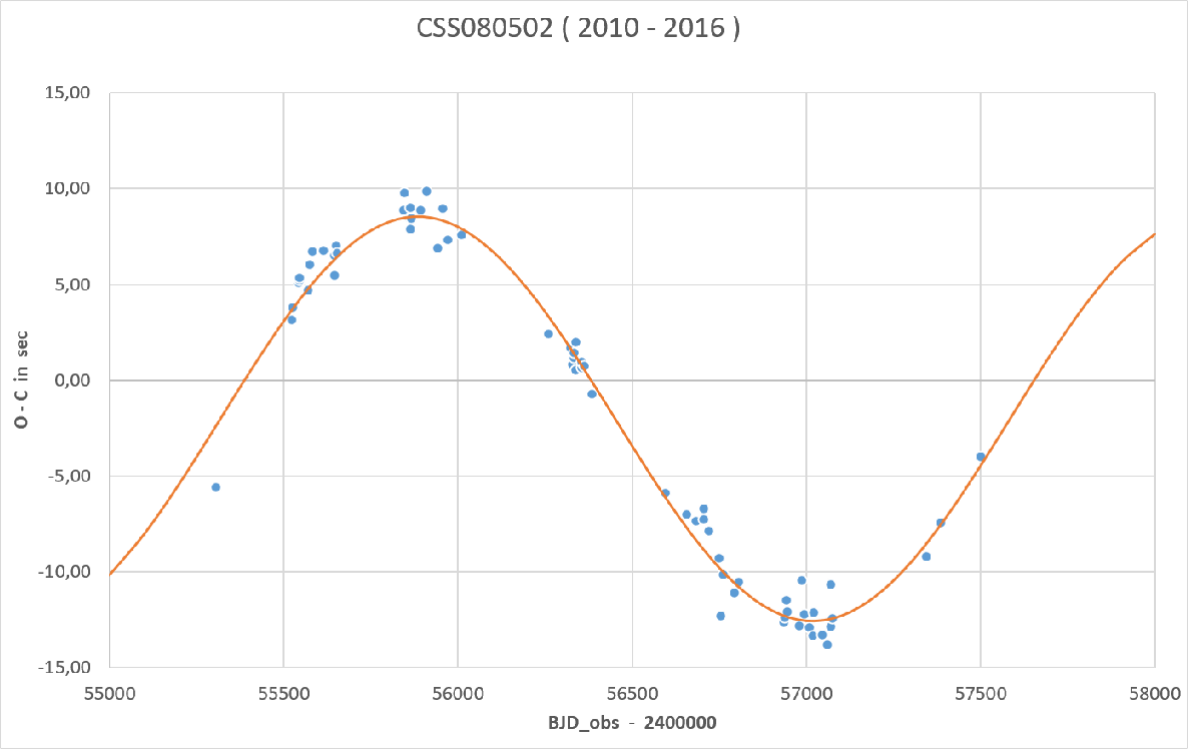

Figure 1: The difference of observed and calculated time shows a significant systematic variation resembling a sine wave. The Datapoints derive from Madelon Bours (University Valparaiso, Chile) and Klaus Beuermann, Paul Breitenstein and Erwin Schwab.

Therefore, I constructed the hypothesis that this sinusoidal difference could be detected further if there is one exoplanet on a circular orbit around its system: A massive exoplanet and the binary star system would orbit around their common centre of gravity. If the system moves towards us as a result, the eclipse appears premature because of the shorter light path; if conversely, the system moves away from us, it appears late.

To confirm this hypothesis, I observed the eclipse with the 1.0m-LCO-telescopes and calculated the theoretical time of the eclipse without the influence of an exoplanet.

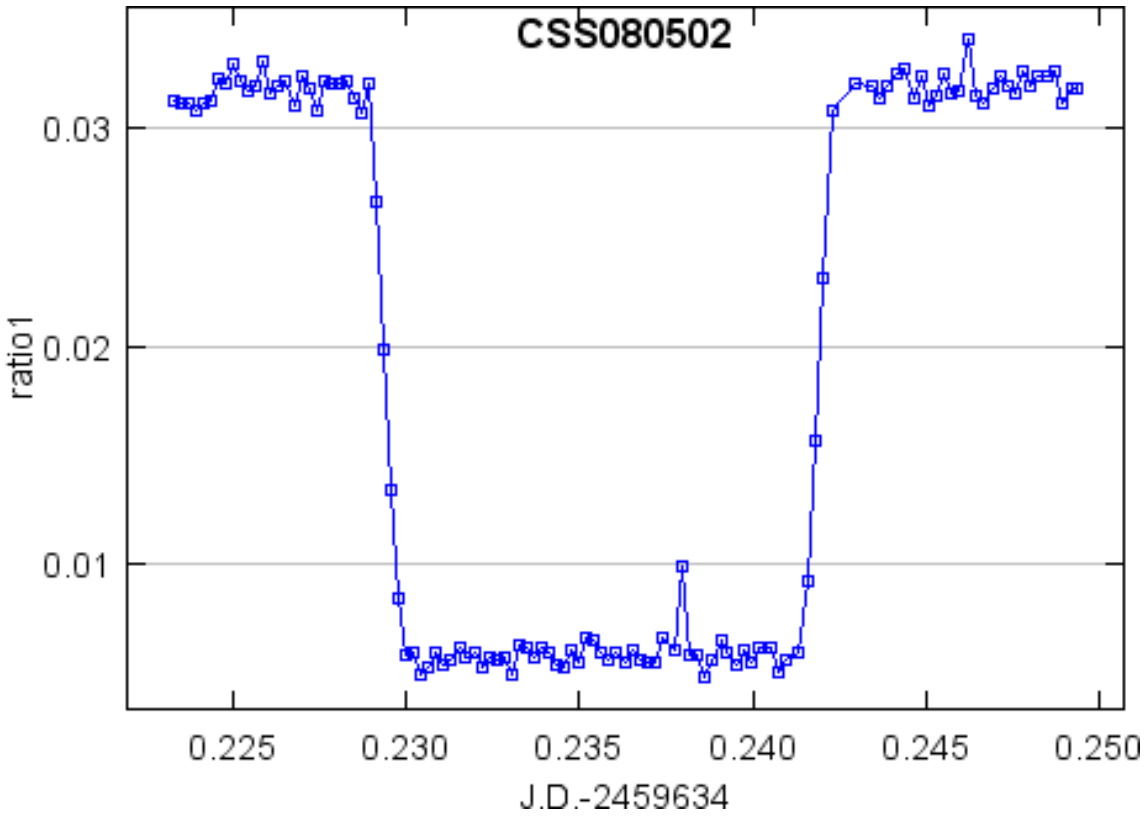

Figure 2: During the eclipse, the apparent brightness of the binary star decreases. The light curve looks box-shaped because of the covered star being much smaller than the covering star.

Trying to understand the connections between the data I gathered and the events in the cosmos was absolutely fascinating. Additionally, being able to do scientific research was something I wanted to do since I developed an interest in astrophysics. After analysing the measured values and comparing them to my calculations, I found no proof of one single exoplanet on a circular orbit. Although I got the result that this easiest of cases did not occur, this does not mean that the binary star system CSS080502 contains no exoplanet.

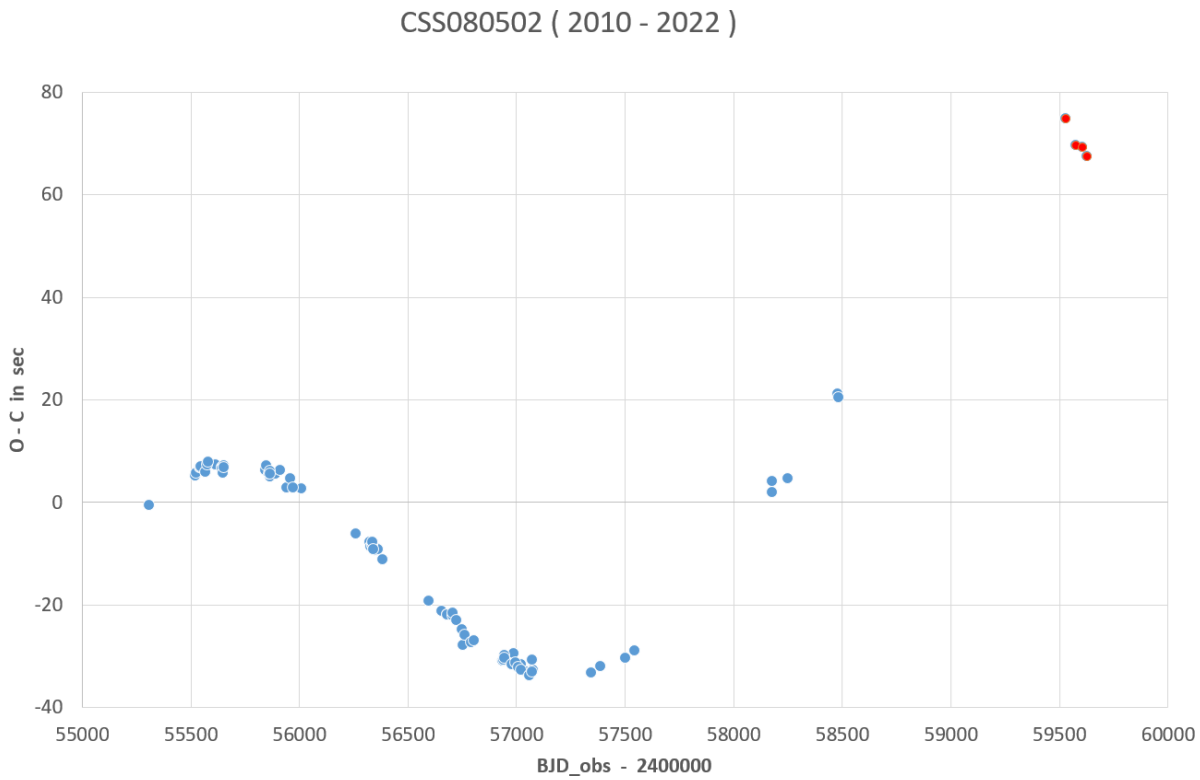

Figure 3: The current measured values (red) show that the variations are much larger than assumed. In addition, the double star system is moving towards our solar system during my observations. The Datapoints before JD2459000 derive from Madelon Bours (University Valparaiso, Chile), Klaus Beuermann, Paul Breitenstein and Erwin Schwab.

Despite not being able to confirm the presence of one exoplanet on a circular orbit, I still found proof of systematic variation. This could be triggered by one or more exoplanets on a highly elliptical orbit. To confirm the presence of one or more exoplanets, I will make more observations with the LCO-network. The binary star system is currently moving towards our solar system at approx. 6600 km/day. We expect a slowdown and reversal in the near future.

Many thanks to Paul Breitenstein/AiM for suggestions and tips and above all to Faulkes Telescope Project for the technical possibilities to participate in current research as a student with professional equipment.