Astronomy 74: Astrophysics
Fall 2024
Dartmouth College

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Paper discussion: A dusty occulter

In this assignment, you will read a scientific paper and prepare a short review. The goal of this assignment is for you to see some of the radiative transfer concepts from class in action. In class, we will review the paper together in your discussion groups following the worksheet format. Following the discussion, each of you will write a short (3 paragraph, 1/2-3/4 of a page single spaced) summary of the article, including a description of the relevant radiative transfer and the key findings. Upload a pdf to Canvas. The target audience for this summary is you and your classmates prior to taking this course, which means, for example, that you should define any words that could be considered "jargon." Please be attentive to presenting the material clearly.

- Deep long asymmetric occultation in EPIC 204376071, Rappaport et al. 2019, MNRAS 485, 2681:
  `https://academic.oup.com/mnras/article/485/2/2681/5362657`

Your summary is due on **Wednesday September 22 at 5pm** via Canvas. Your summary will be graded on three areas (10 points total):

- Scientific scope: did the summary cover the key areas of the article, without unnecessary detail? (3 points)
- Radiative transfer scope: did the summary cover the key radiative transfer concepts underpinning the research? The discussion questions can help guide. (3 points)
- Accuracy: was the summary factually accurate? (2 points)
- Clarity: was the summary coherent and understandable to the target audience? (2 points)

For Friday, September 22: Read the above articles (you won't understand everything!) before class. When you are reading the articles, consider the following questions:

- What motivated this study? What were the key discoveries?
- On what physics is this study based? Where and how do radiative transfer concepts get used?
- What questions did this paper bring up for you? What things didn't you understand? How would you go about answering them?

Questions for in class. Note: occultation is a generally term for "something passing in front of and blocking the light from something else;" a planet transit and a binary star eclipse are two examples of occultations.

- What are a few examples of "dusty occulters"?
- What observations were used in the discovery?
- What do we know about the age of the host star?
- How much of star's light is blocked during the occultation?
- SEDs
  - How is the SED presented in this paper?
  - What data were combined to produce the SED?
  - Approximate the peak wavelength of the SED. What's the temperature of the star from this calculation? How does is it compare to the temperature reported in the paper for the star?
  - How were the stellar parameters (radius, luminosity, and temperature) determined from the SED?
  - The stellar parameter fitting mentions *reddening*, which is given by E(B-V). This tells you the differential amount of extinction in the B versus V filters, which is generally due to dust along the line of the sight to the object. At optical wavelengths, dust always makes a source look *redder*. What does this say about τ_v?
- Why do starspots and flares produce variations in the stellar lightcurve? What equation(s) in R&L are useful for assessing the amount of contribution?
- Models
  - What are the two general models that are fit to the occultations?
  - Three separate possible equations for the dust sheet model are given in Eq 1. What equation(s) in R&L are the basis for these equations? How were Eq 1 derived? What's the typo in Equation 1?
  - How was the total mass of the dust estimated? What equation(s) in R&L are the basis for this estimate?
  - The overall minimum mass of the dust is estimated to be fairly small (1000 times less than Saturn's rings). The paper then goes on to discusses how optical depth depends on dust grain size. What would be required to get a dust mass closer to that of Saturn's rings? Does the data constrain this?
- The paper doesn't really discuss the importance of this type of research. Besides it being a cool phenomenon (which, having met the lead author, is definitely one of the reasons why they looked into it), why do you think it might be more broadly interesting to look into objects like this?