

# BINARY SYSTEMS

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ASTROPHYSICS

Dr H.T.Sener

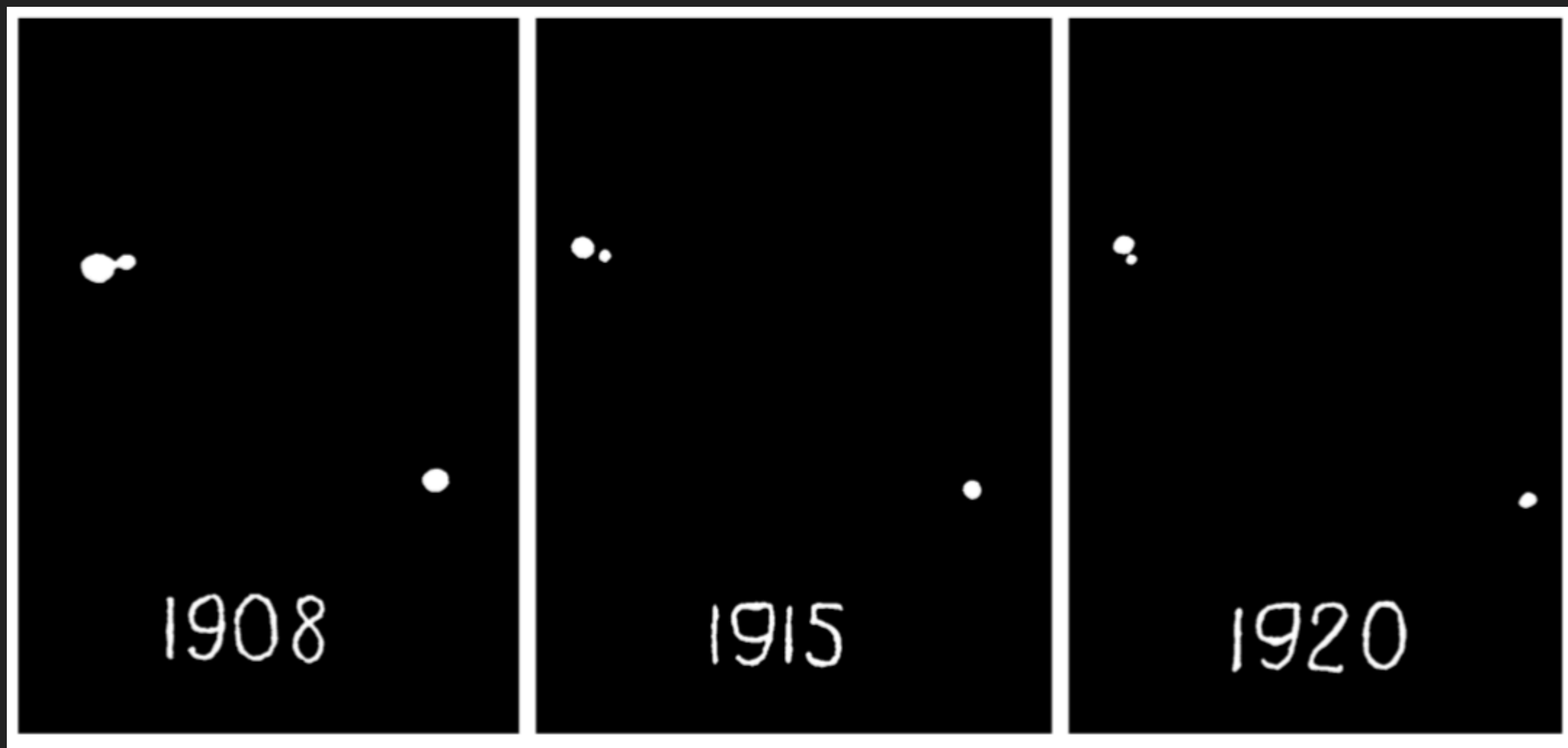
# BINARY SYSTEMS

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- ▶ Two stars orbiting around the center of mass.
- ▶ Primary: Brighter, massive, stationary
- ▶ Secondary: Less bright, less massive, orbiting
- ▶ More than 50% of stars are in a binary/multiple system
  - ▶ Visual
  - ▶ Eclipsing
  - ▶ Spectroscopic

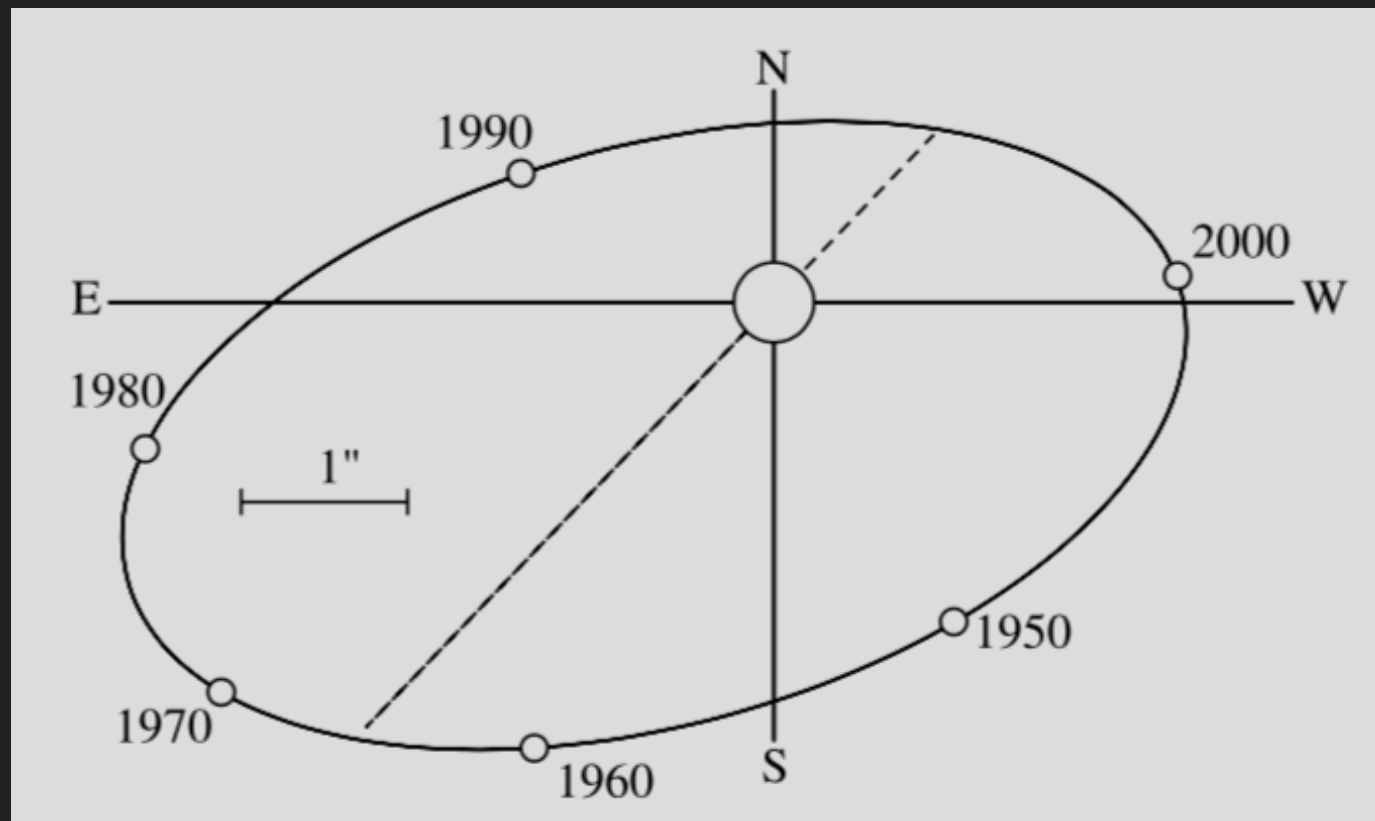
# VISUAL BINARIES

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Yerkes Observatory

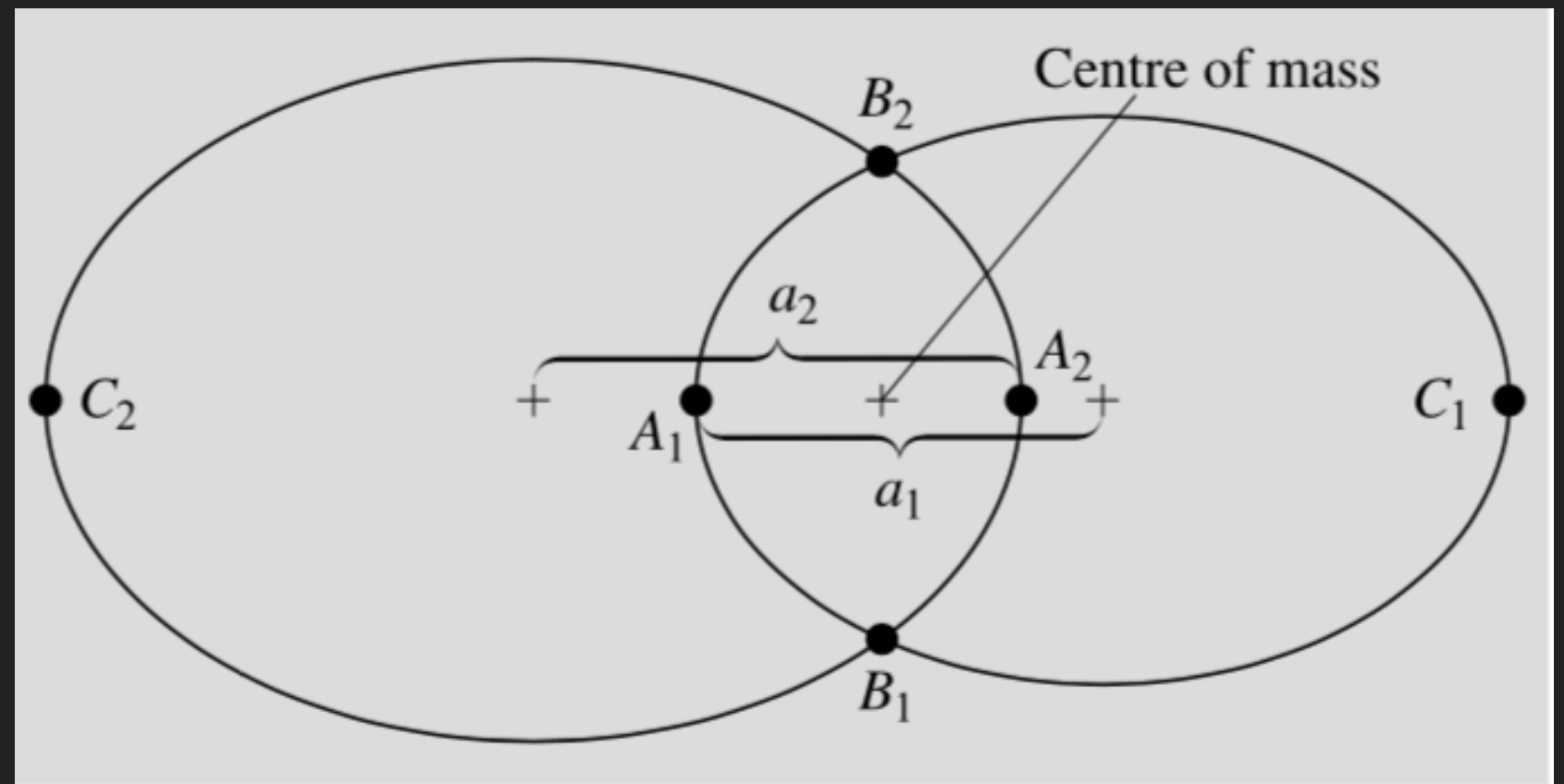
# BINARY ORBIT



- $\xi$  Ursae Majoris was the first binary orbit determined observationally

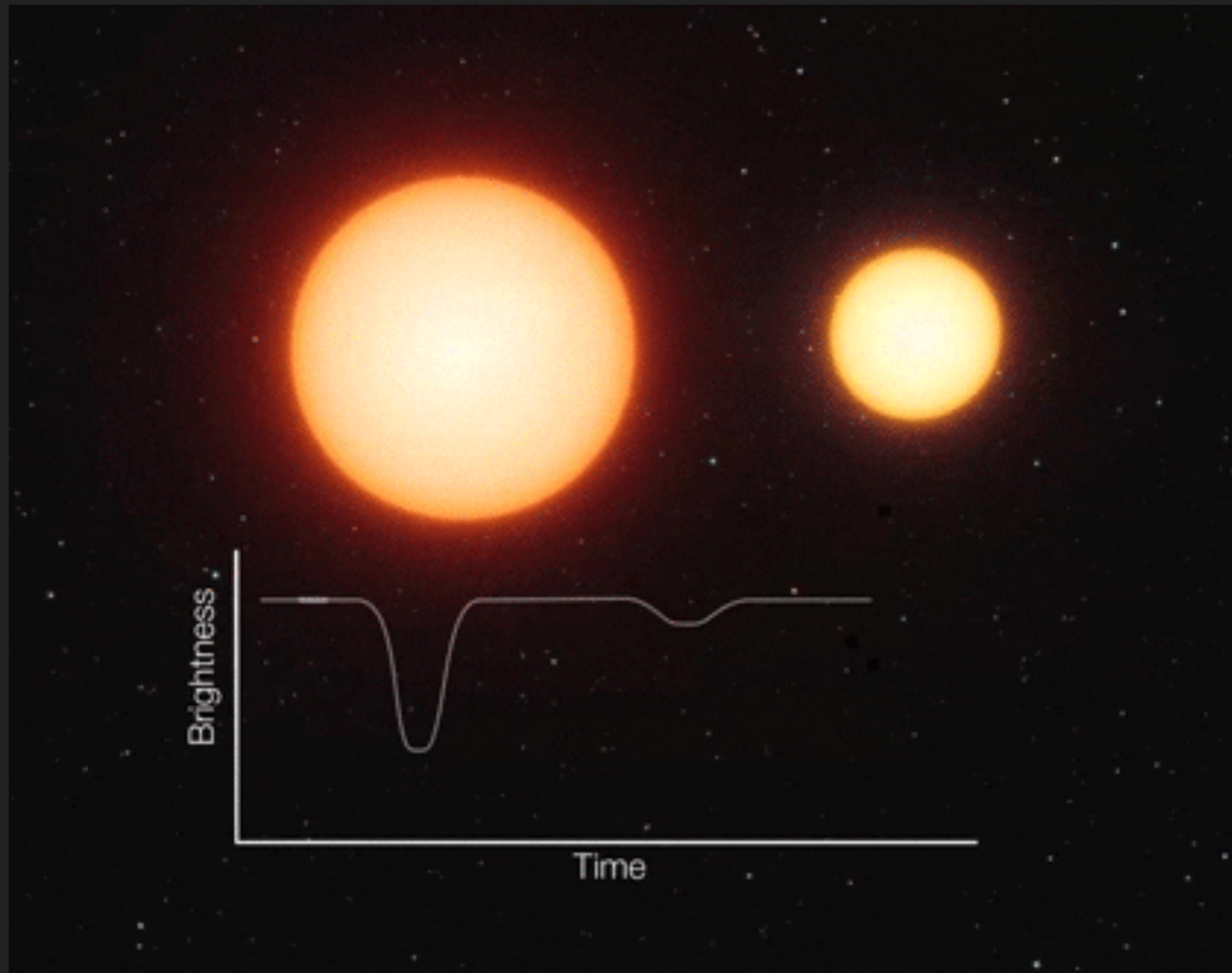
Semi-major axis of the relative orbit:

$$a = a_1 + a_2$$

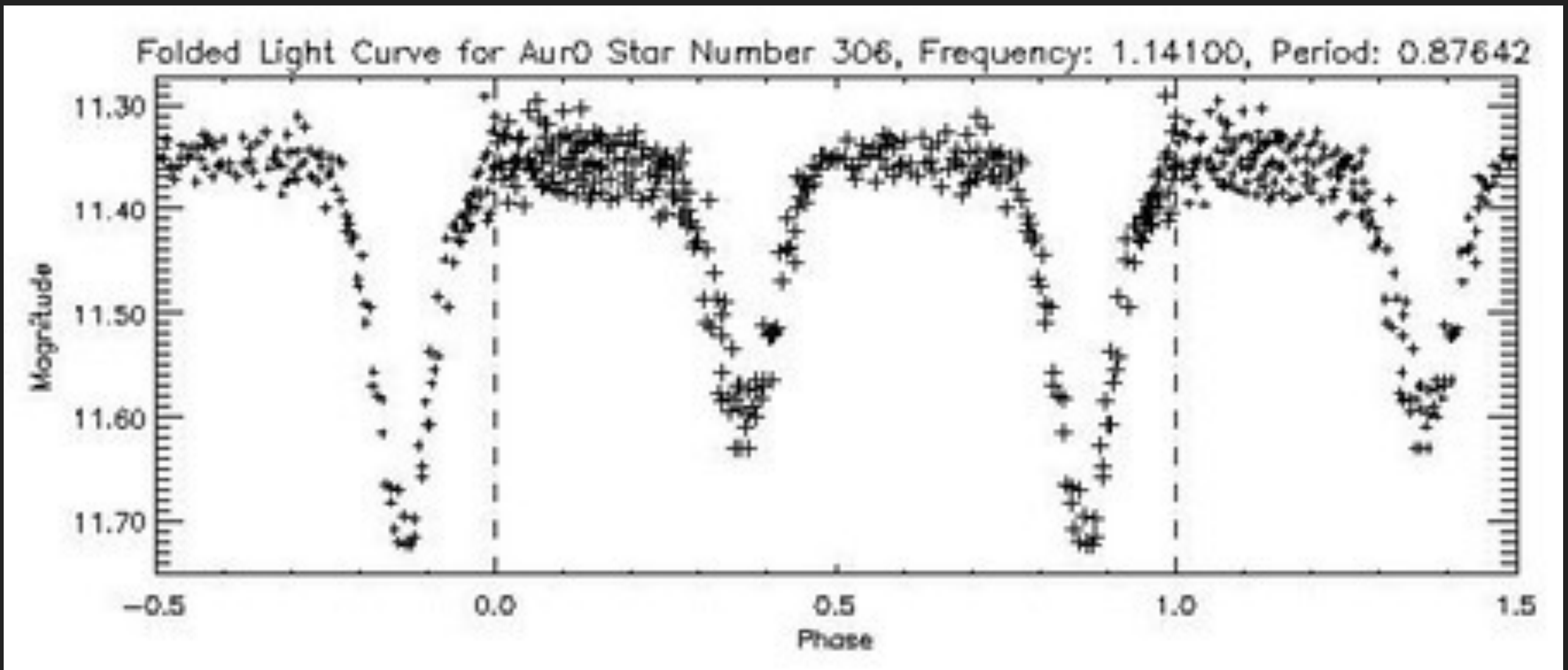


# ECLIPSING BINARIES

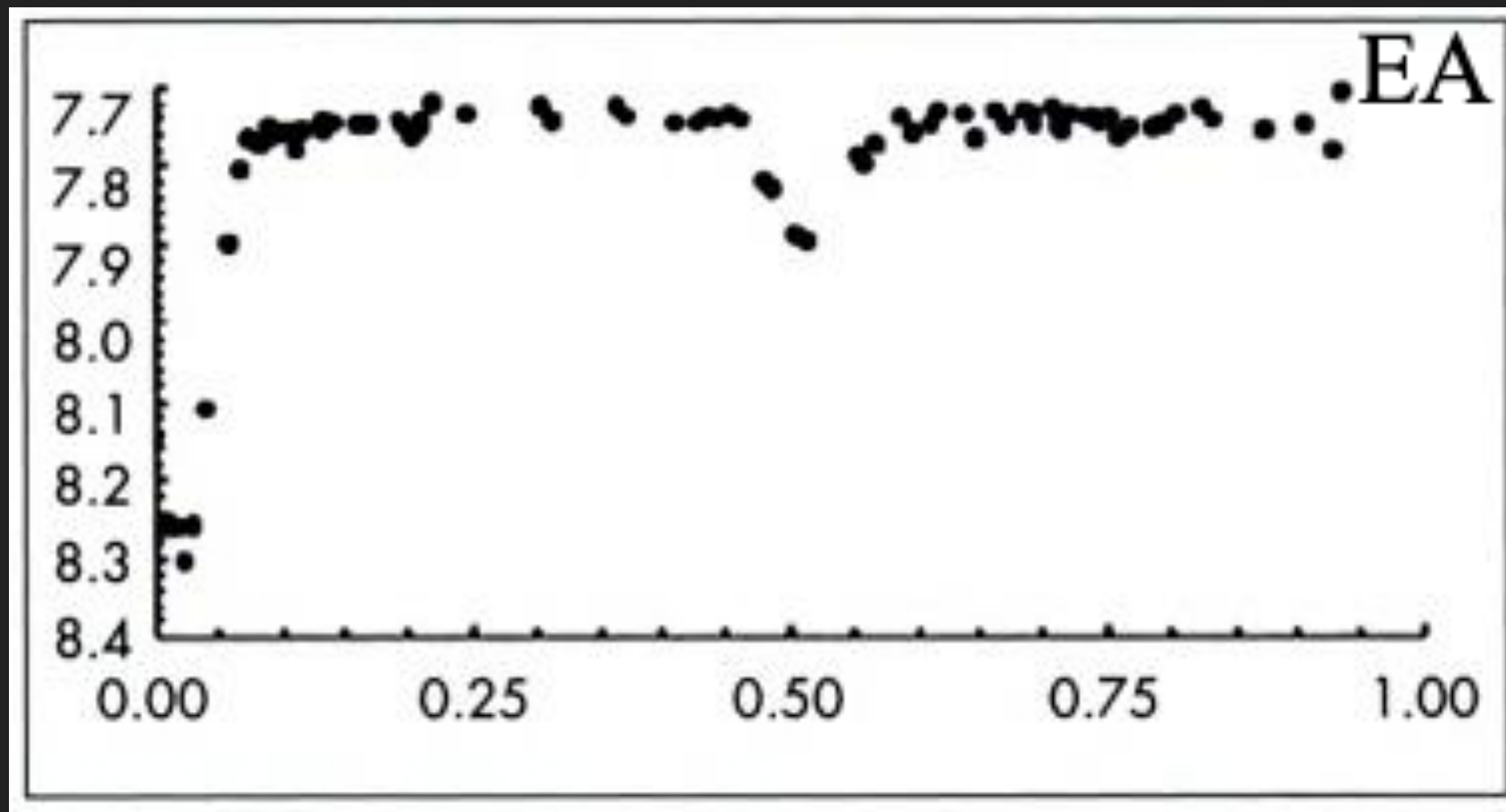
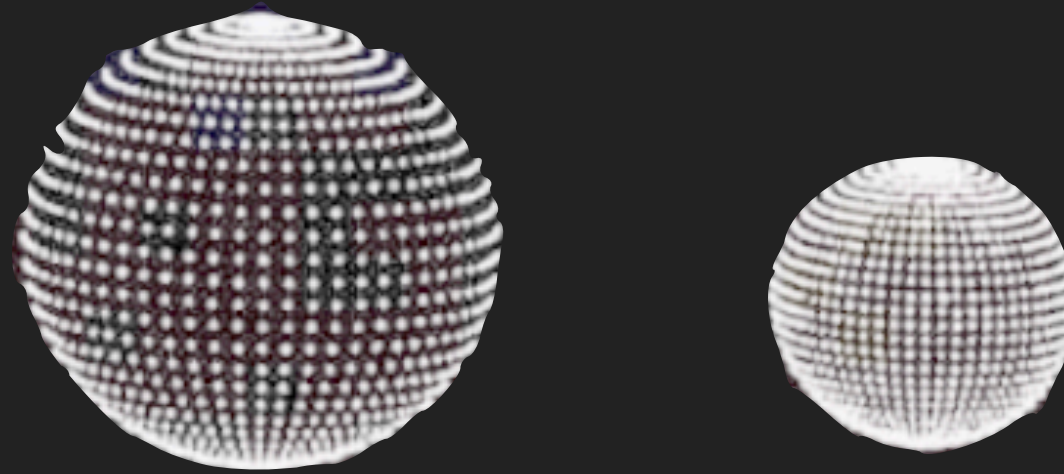
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# PERIOD

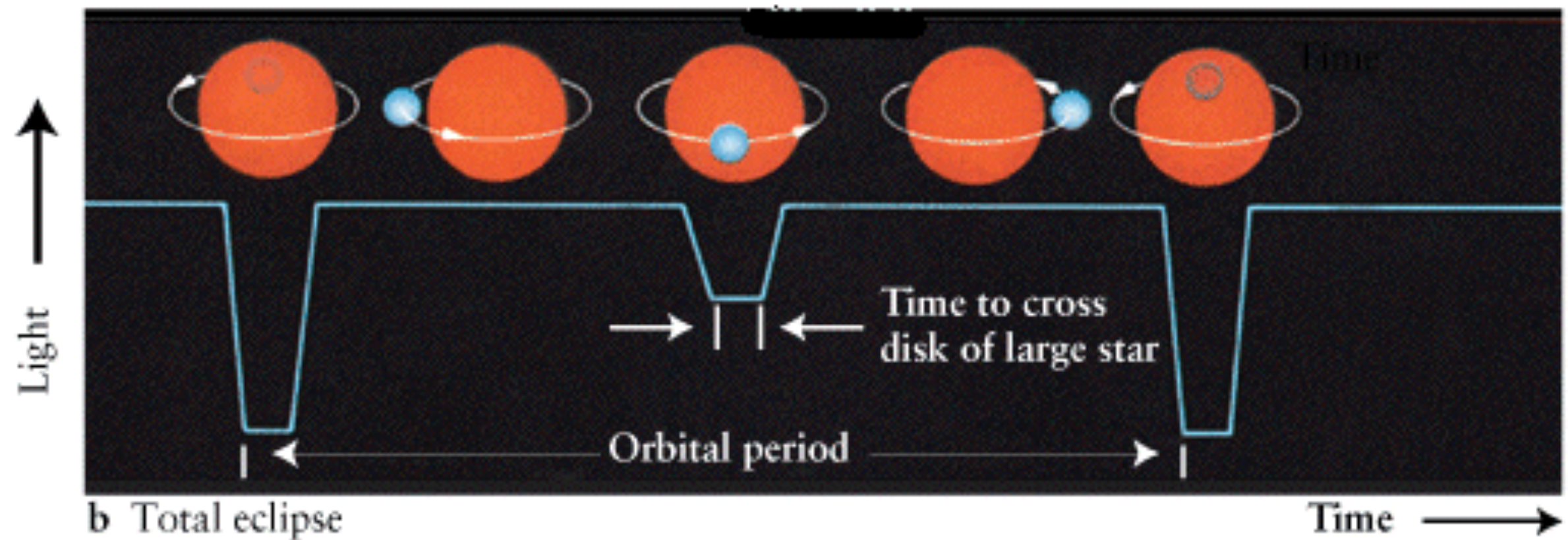
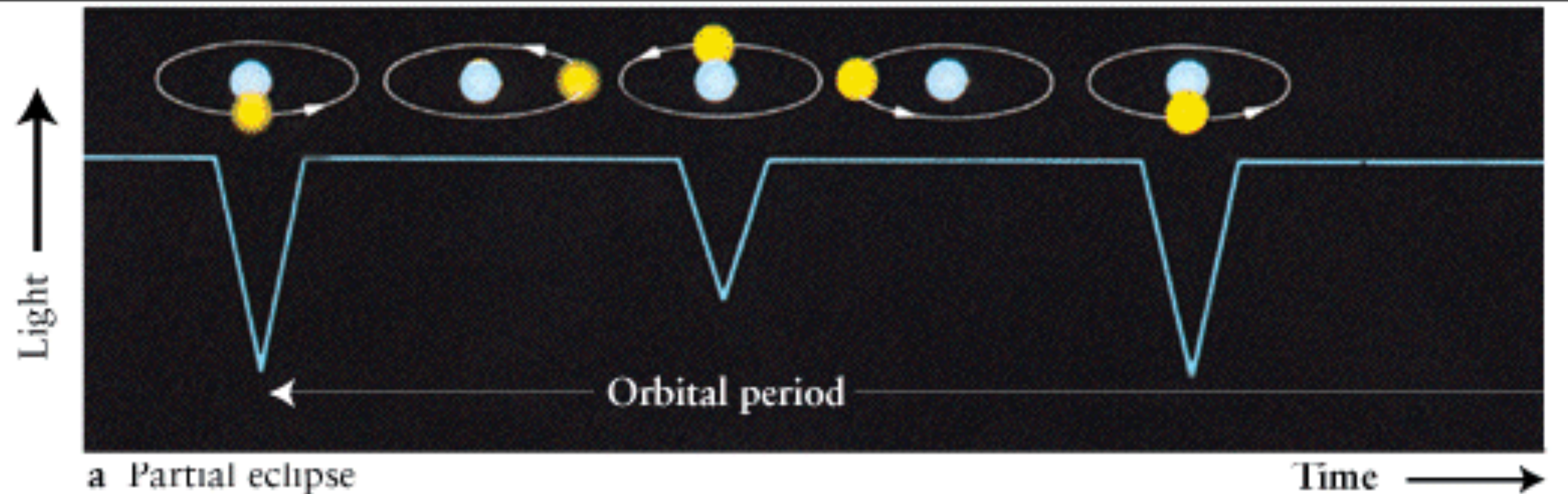


# EA - ALGOL



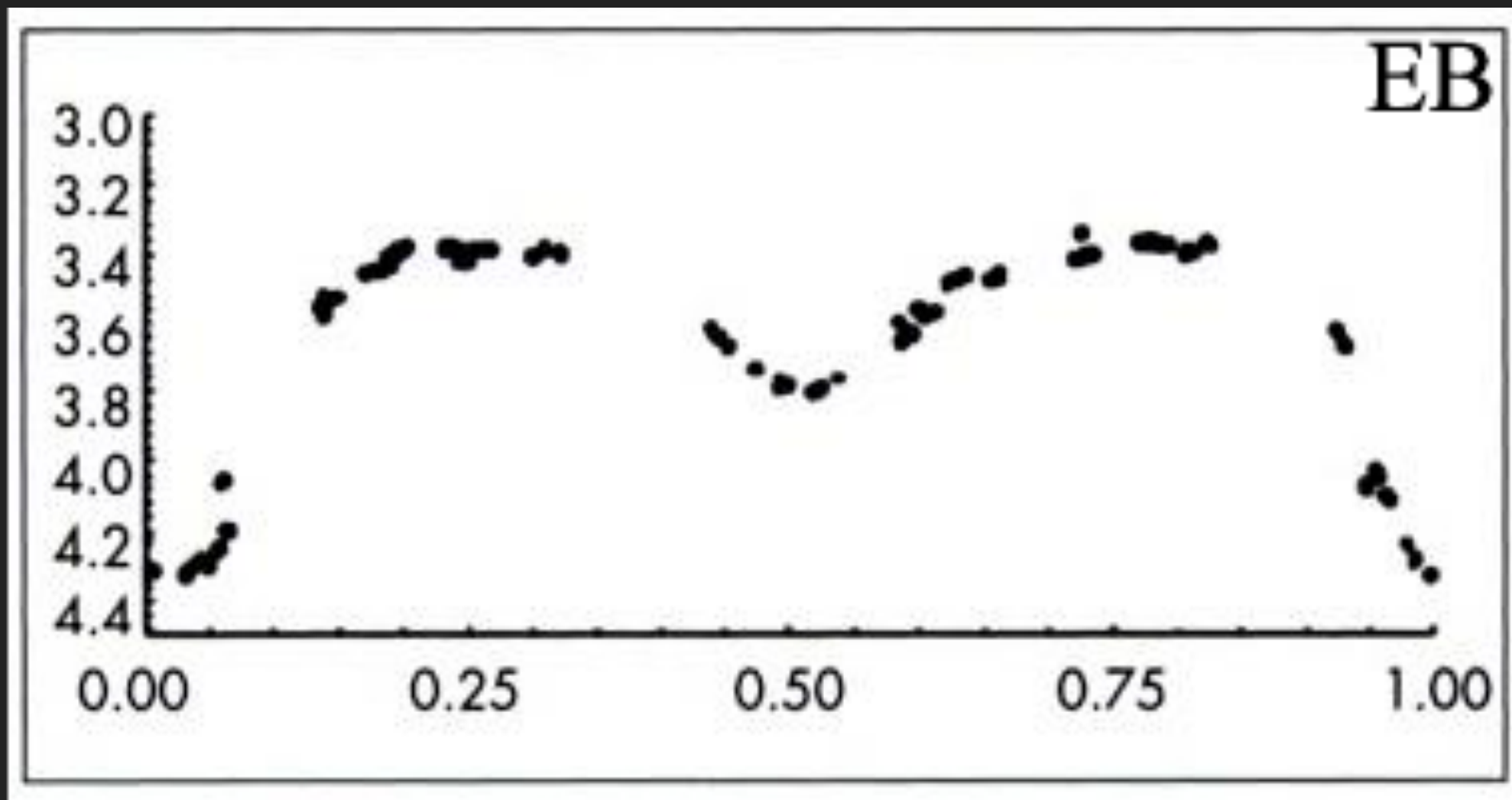
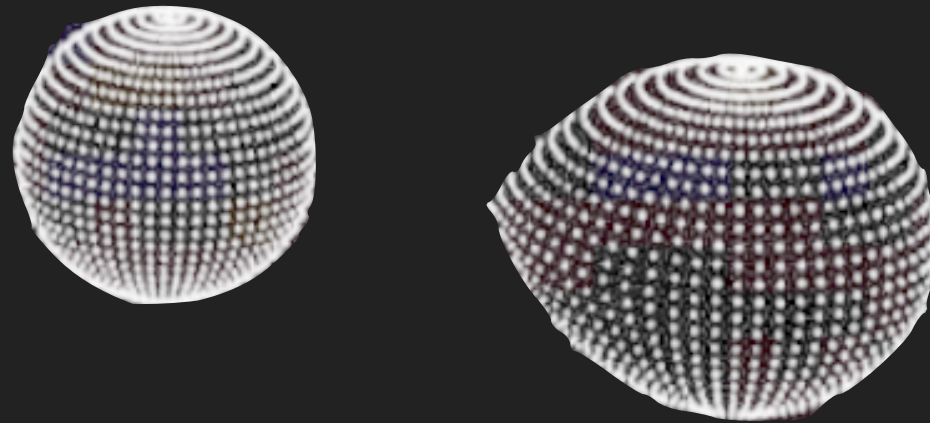


# EA - ALGOL

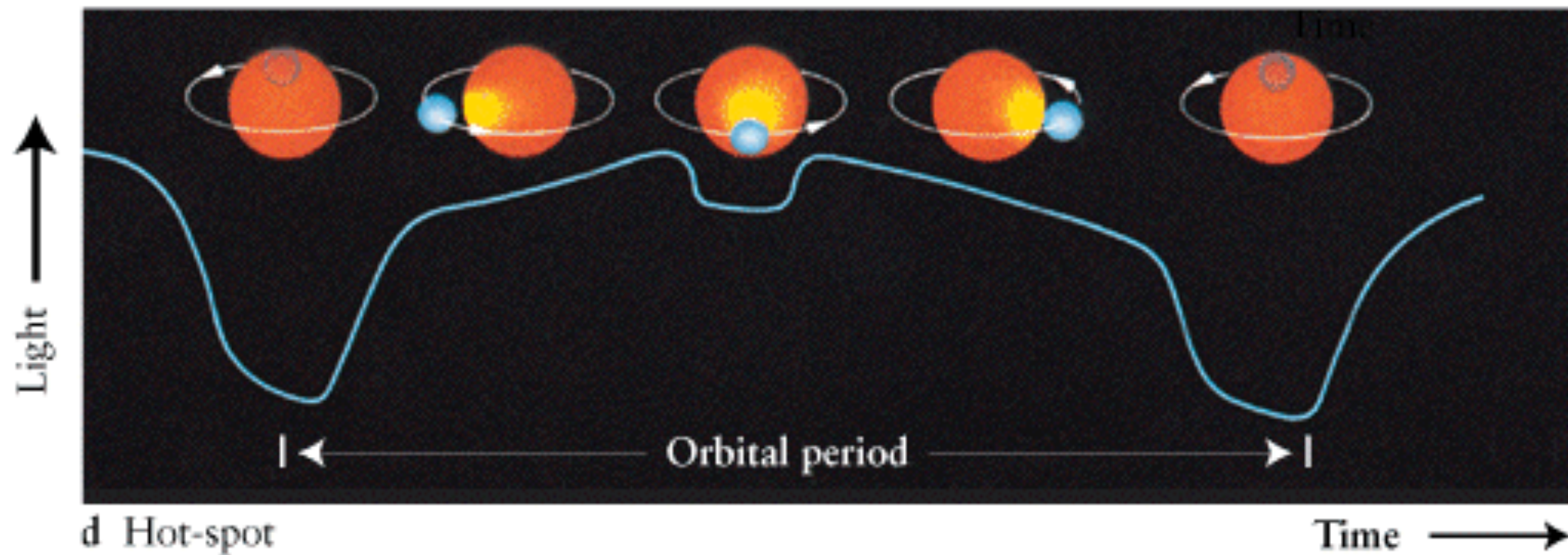
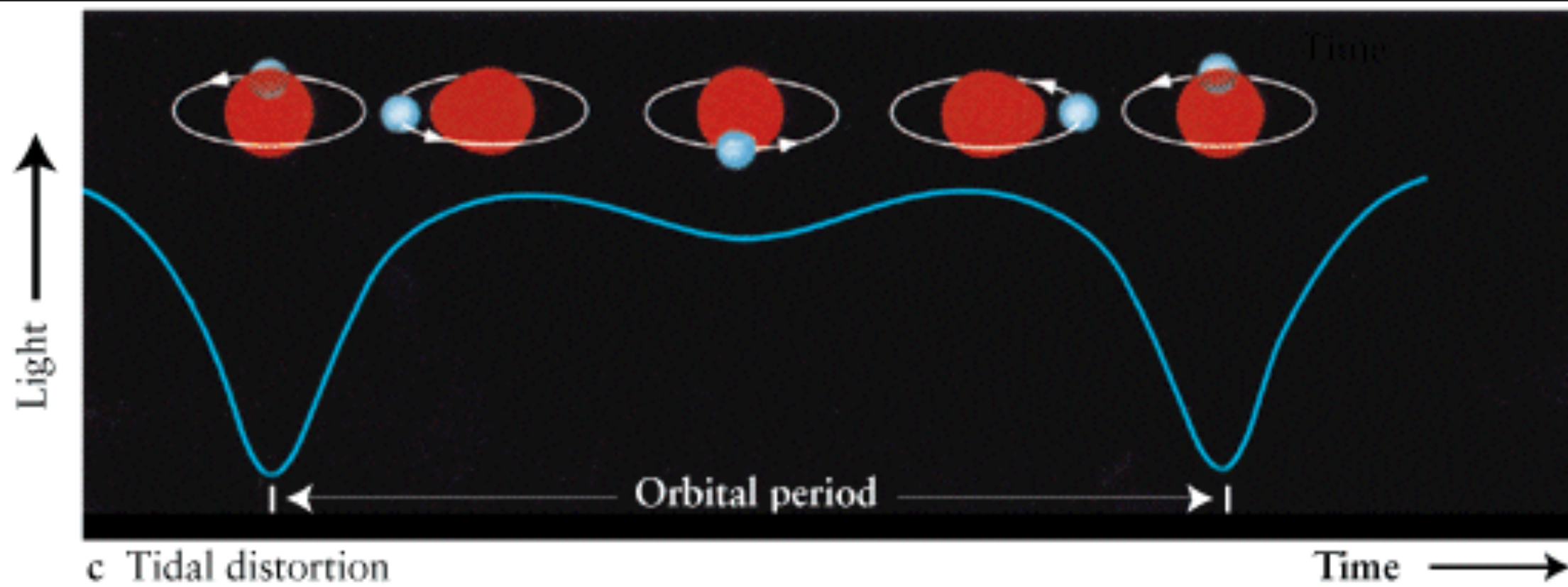




# EB – BETA LYR

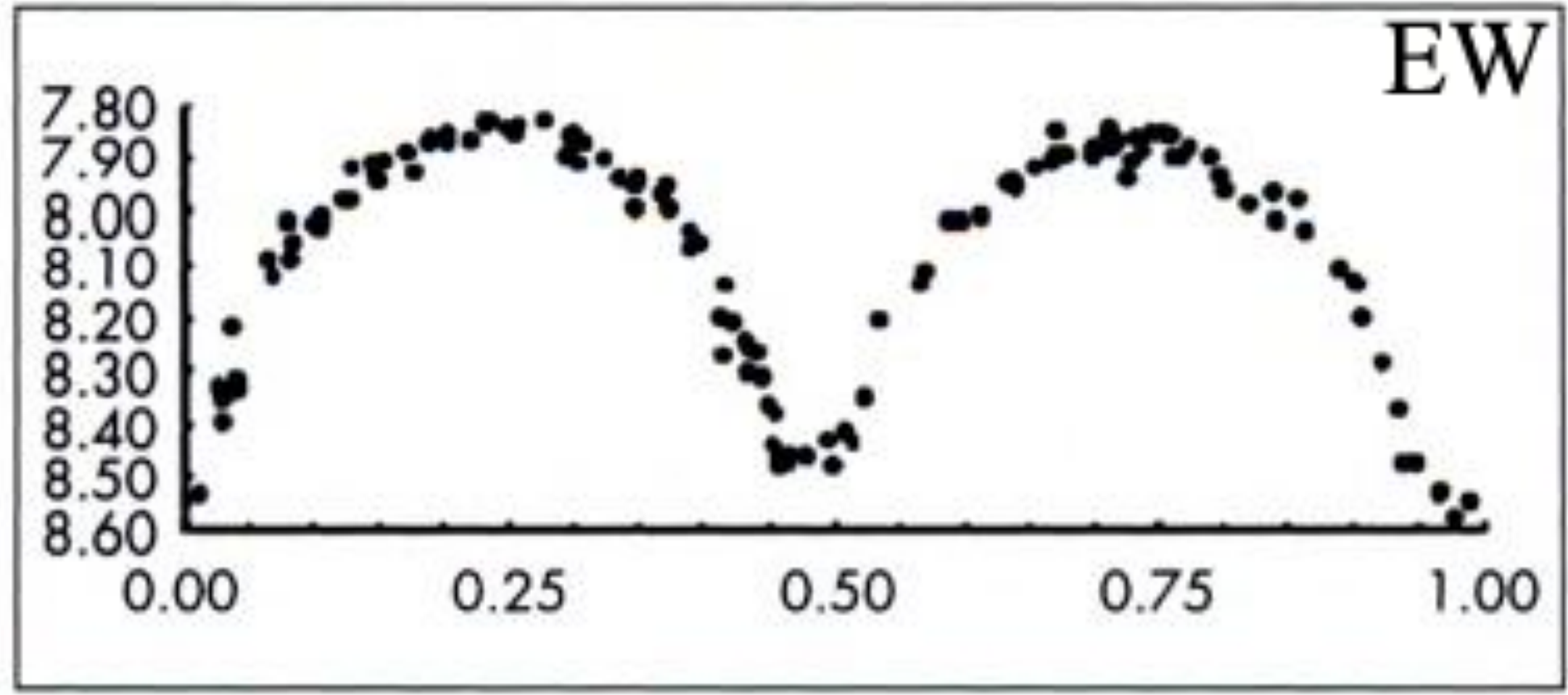
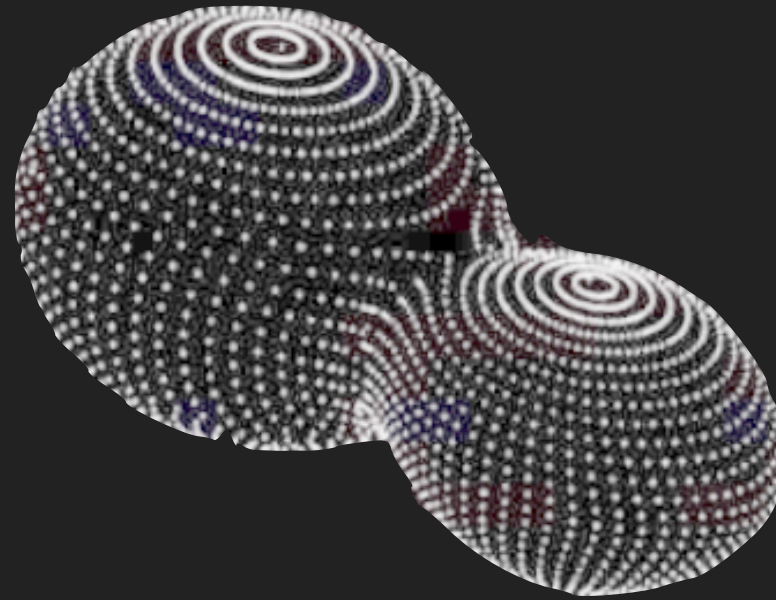


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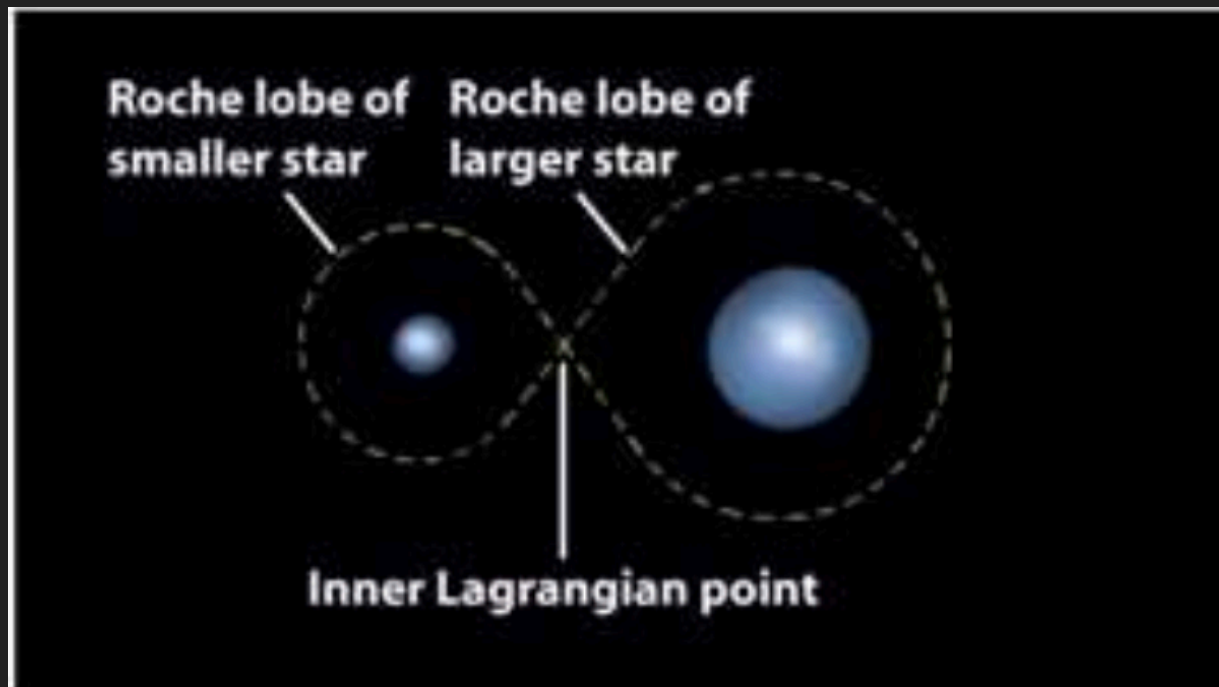




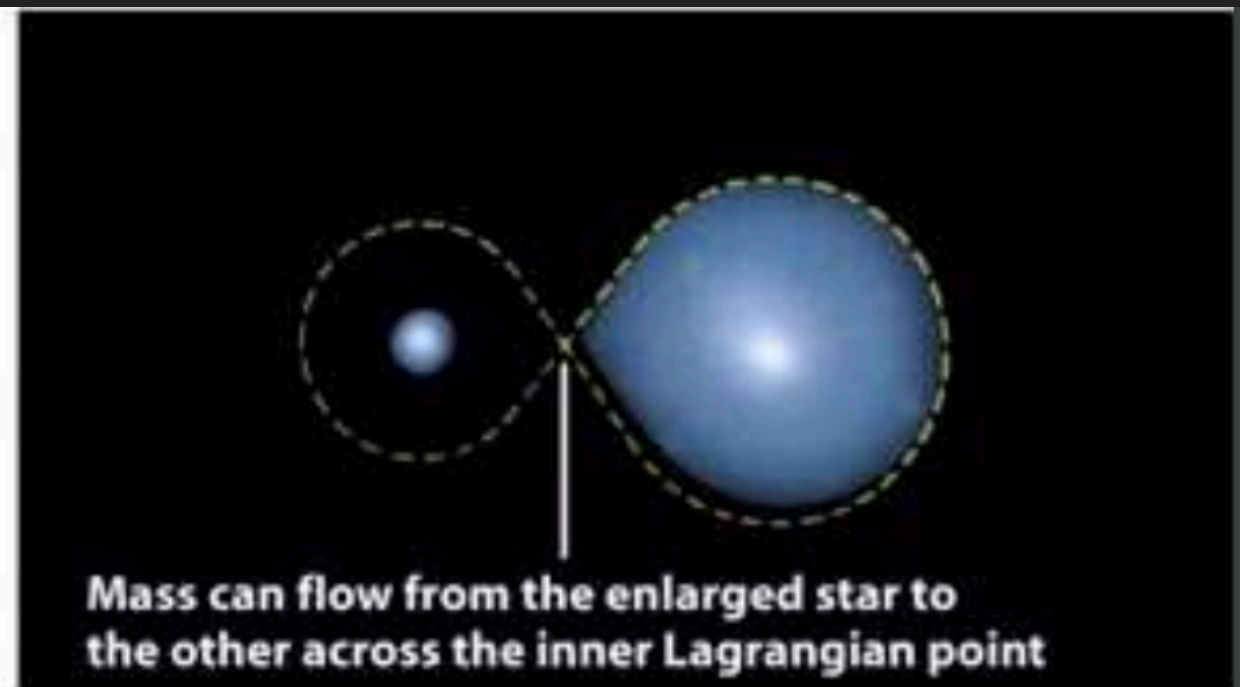
# EW – W UMA



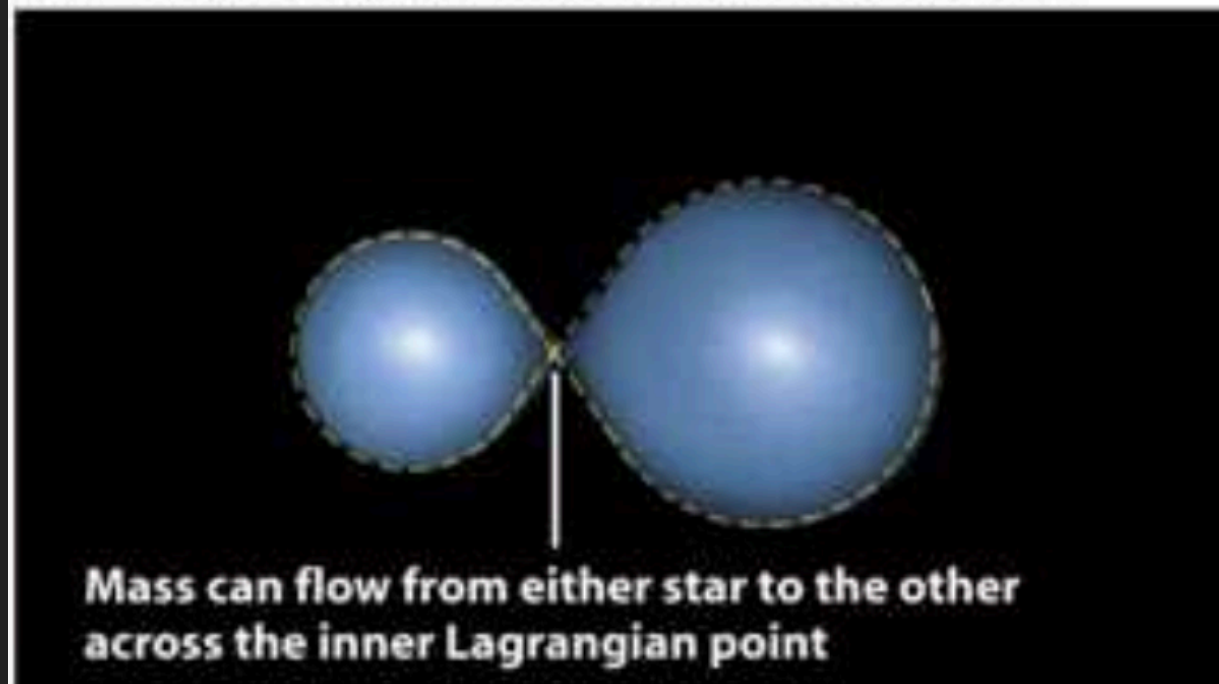
# ROCHE LIMIT



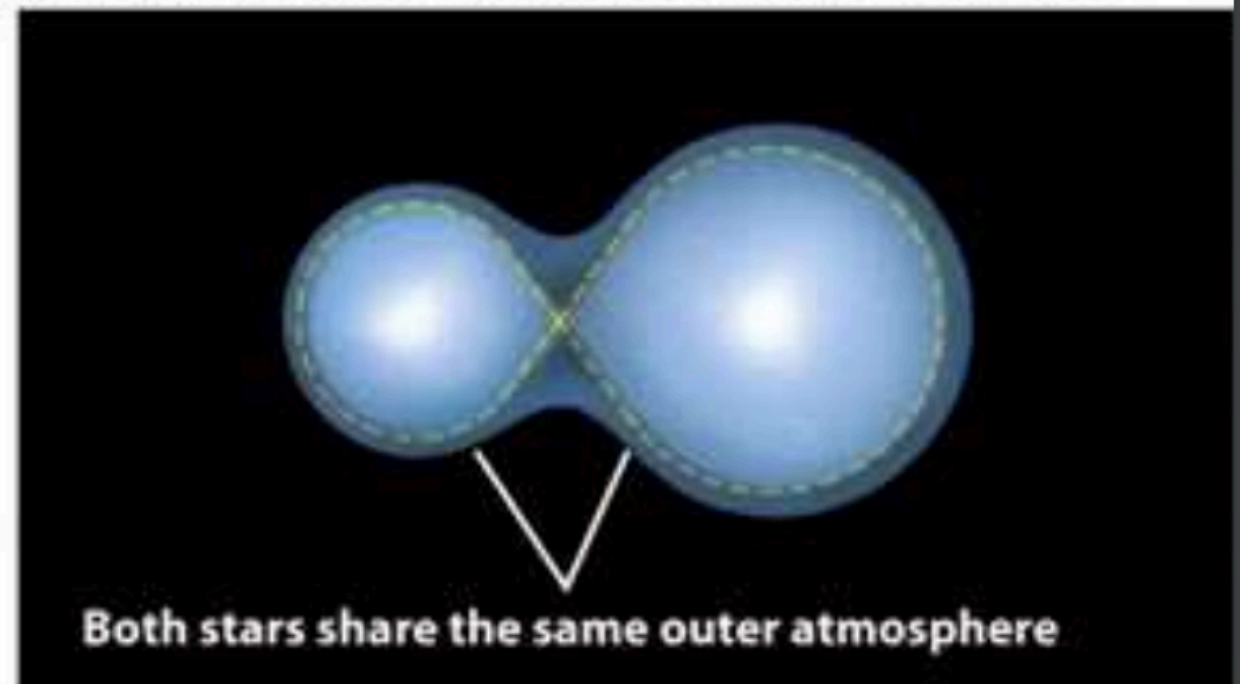
(a) Detached binary: Neither star fills its Roche lobe.



(b) Semi-detached binary: One star fills its Roche lobe.



(c) Contact binary: Both stars fill their Roche lobes.



(d) Overcontact binary: Both stars overfill their Roche lobes.

Figure 19-20

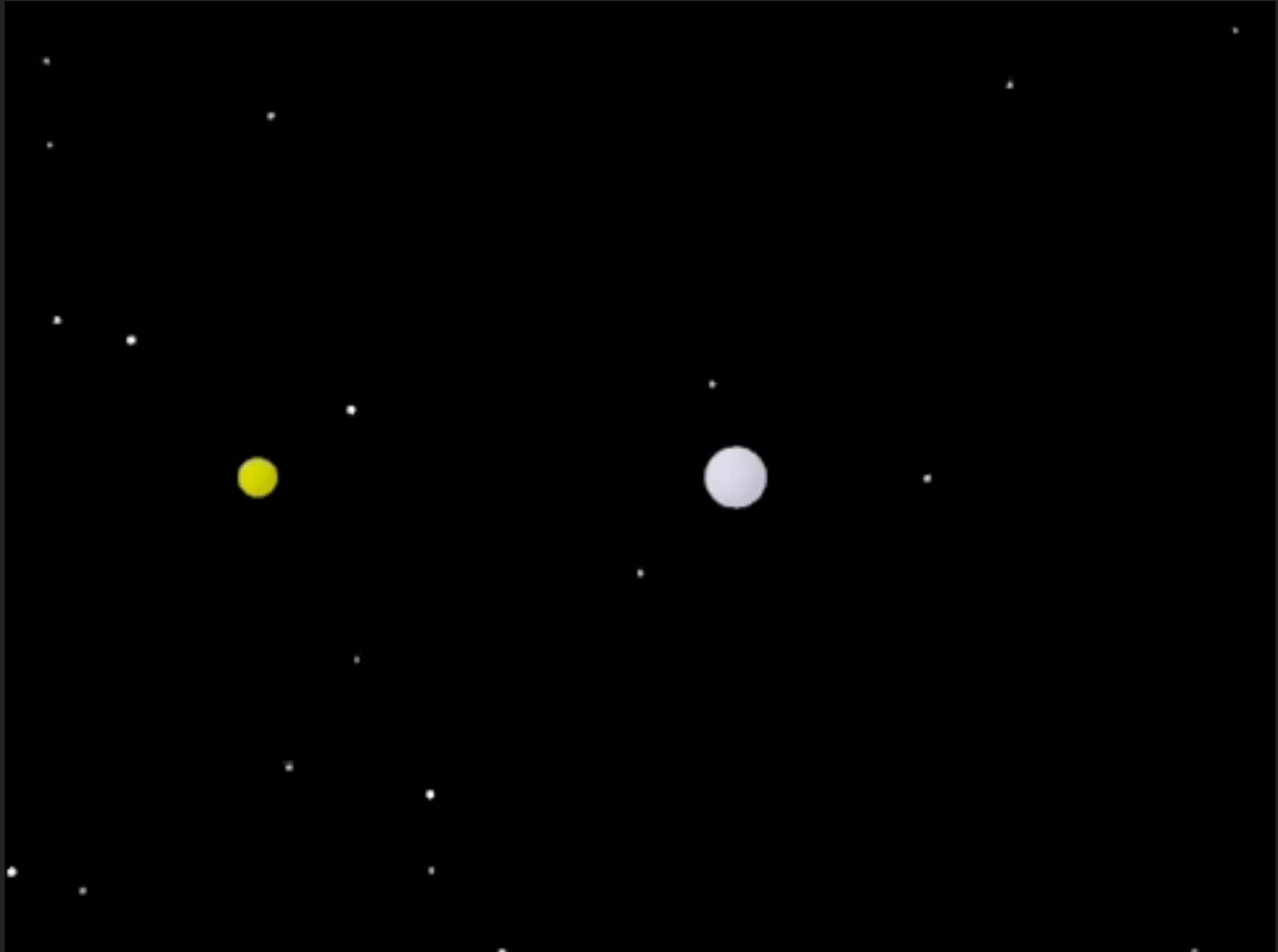
*Universe, Eighth Edition*

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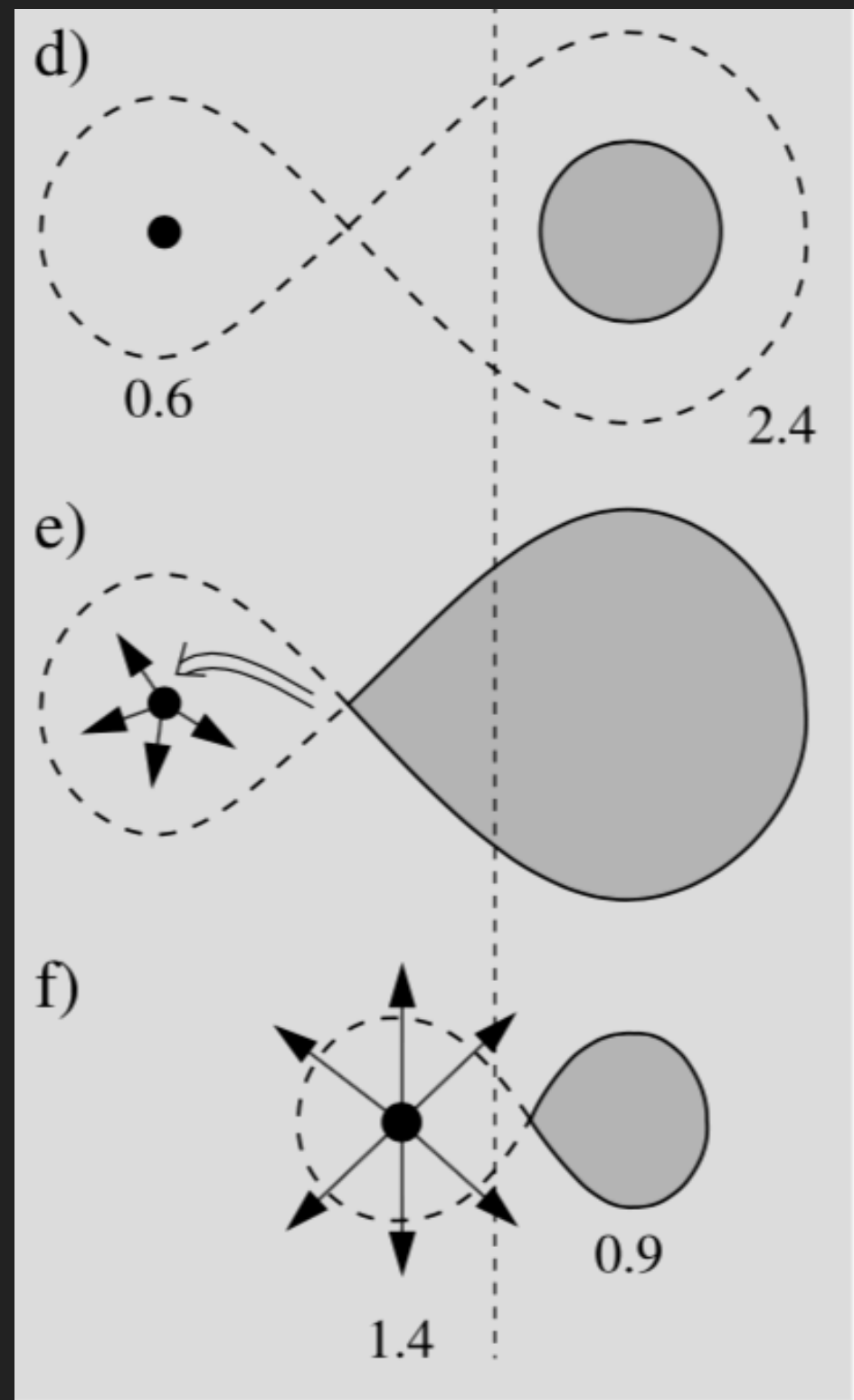
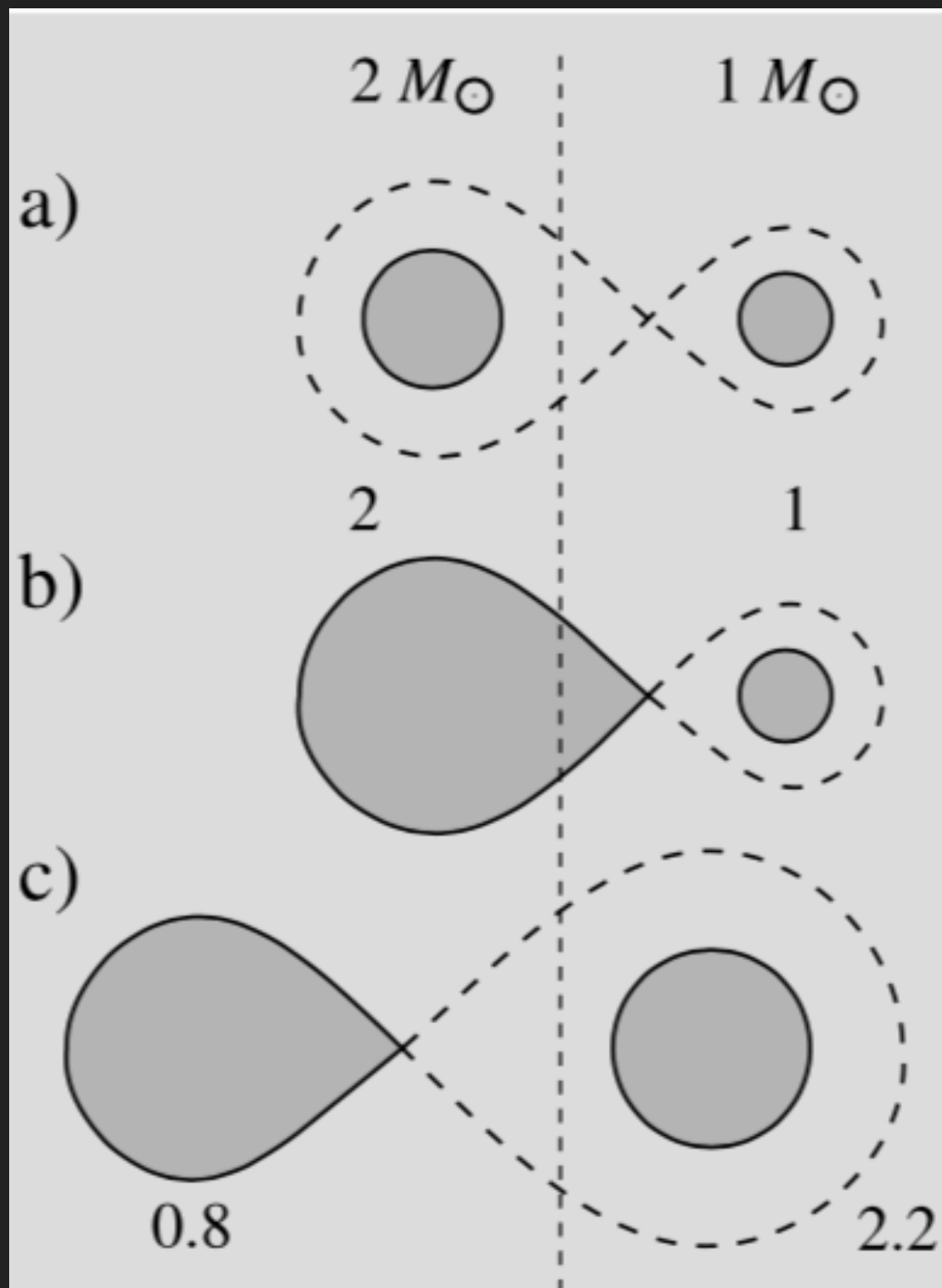


# ALGOL PARADOX

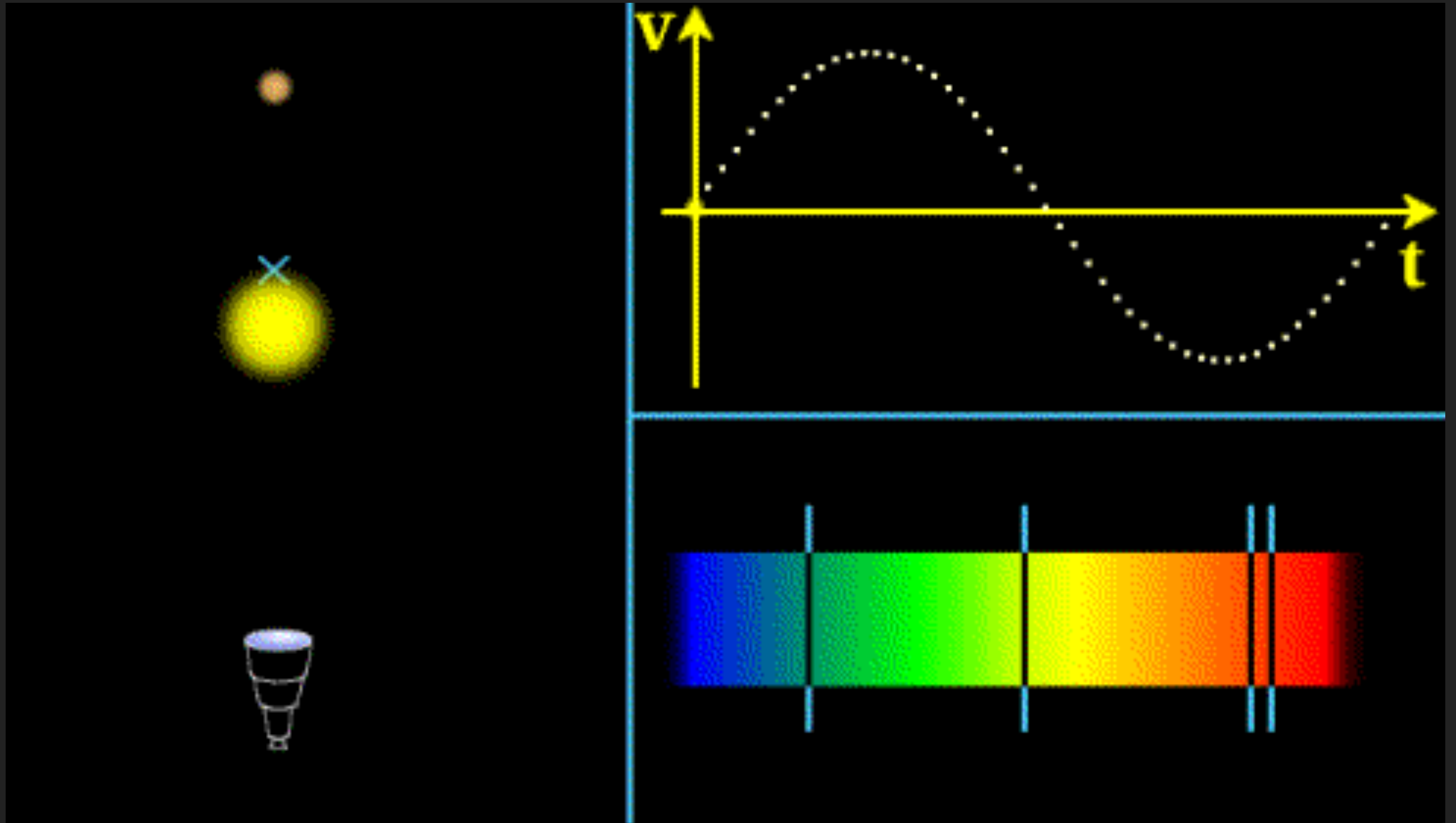
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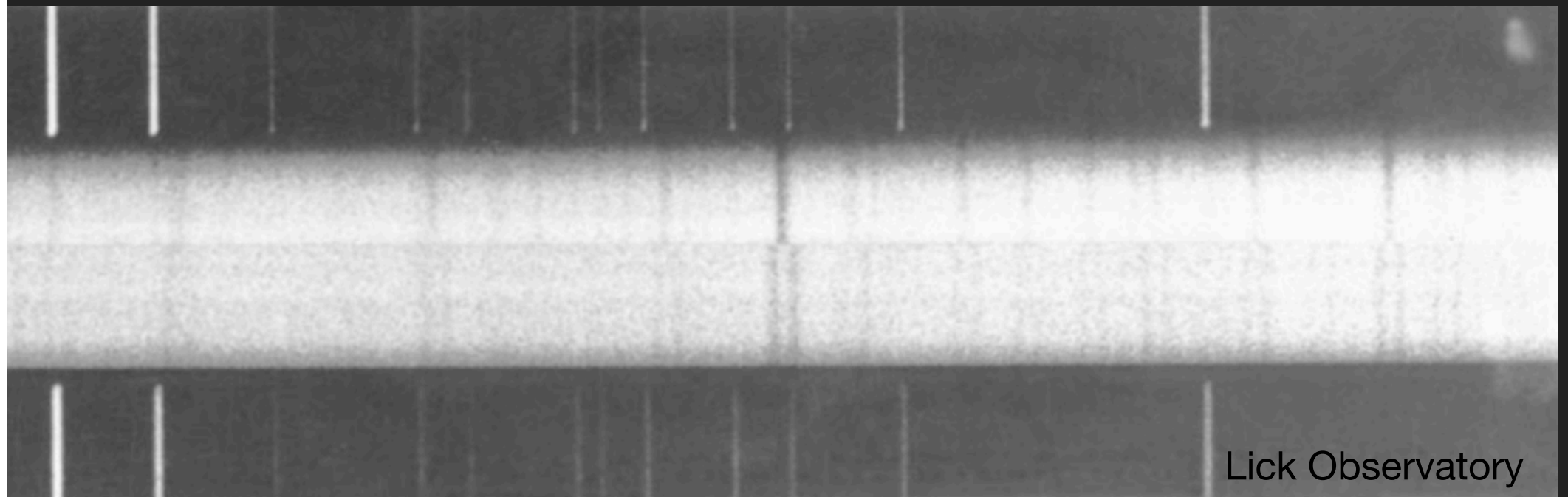
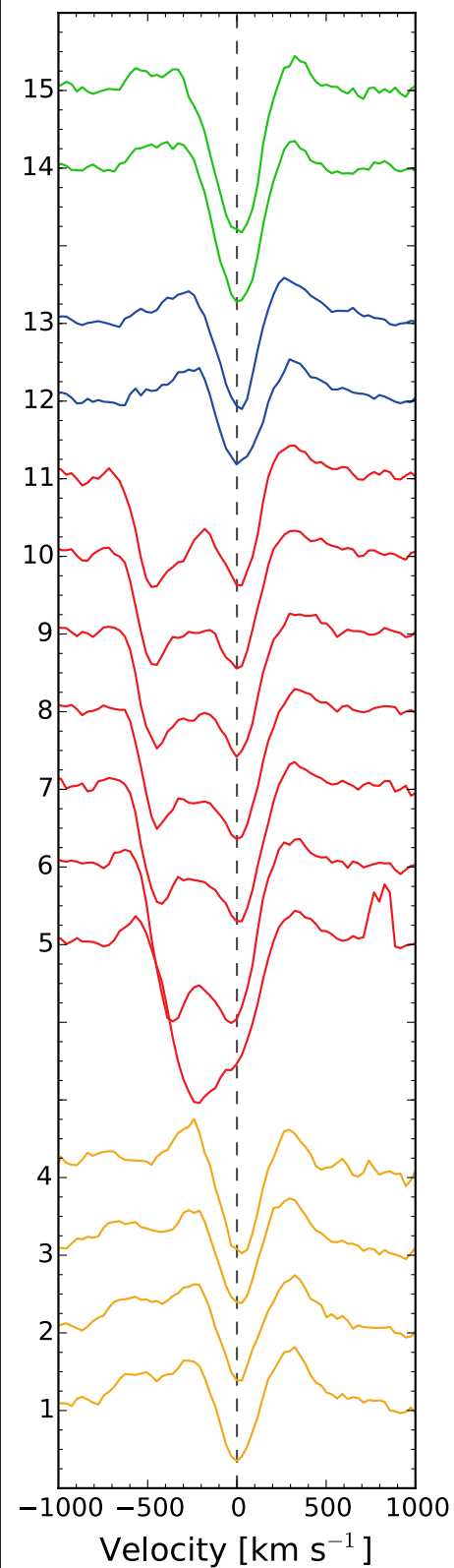
# EVOLUTION OF A LOW MASS BINARY



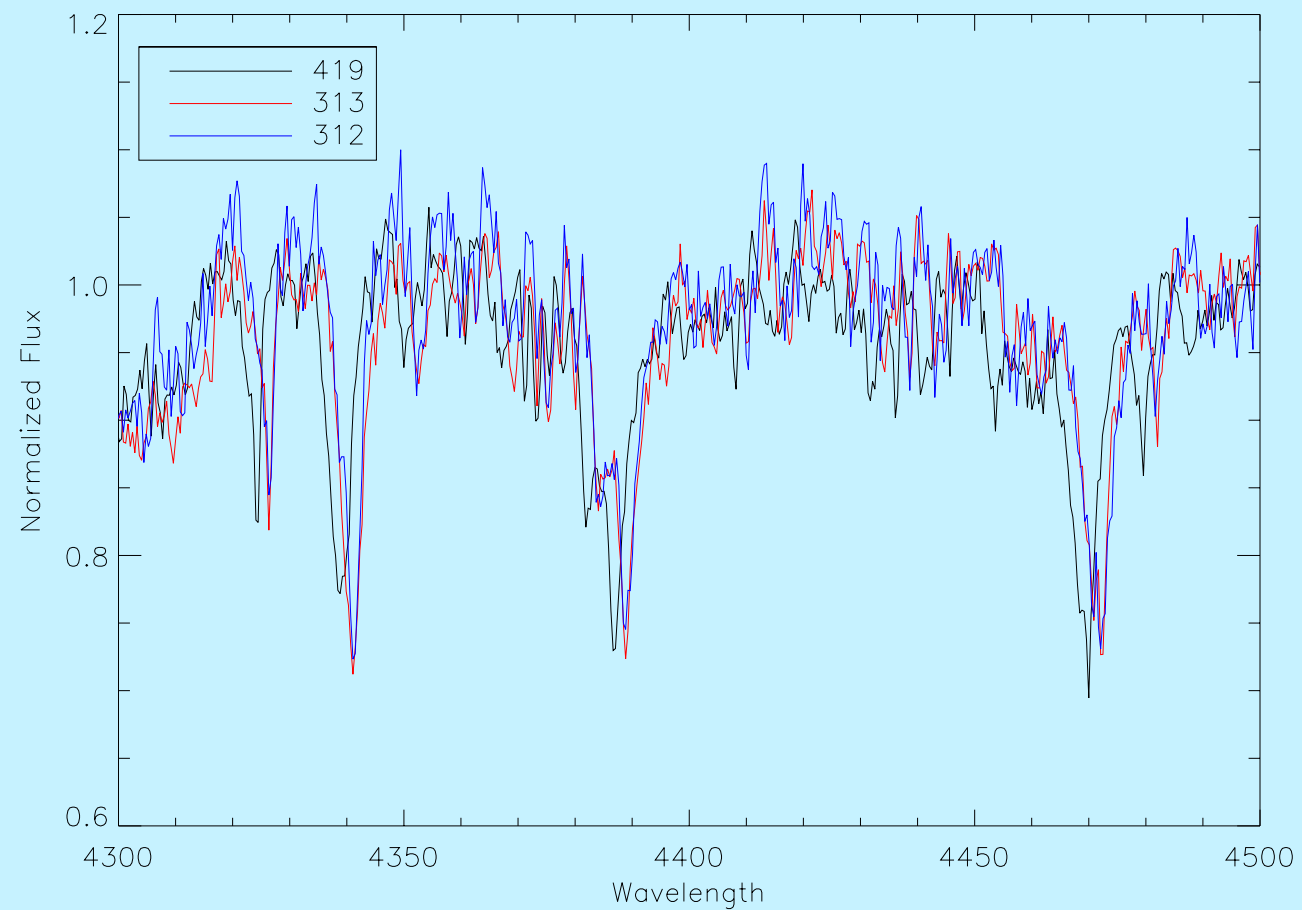
# SPECTROSCOPIC BINARIES



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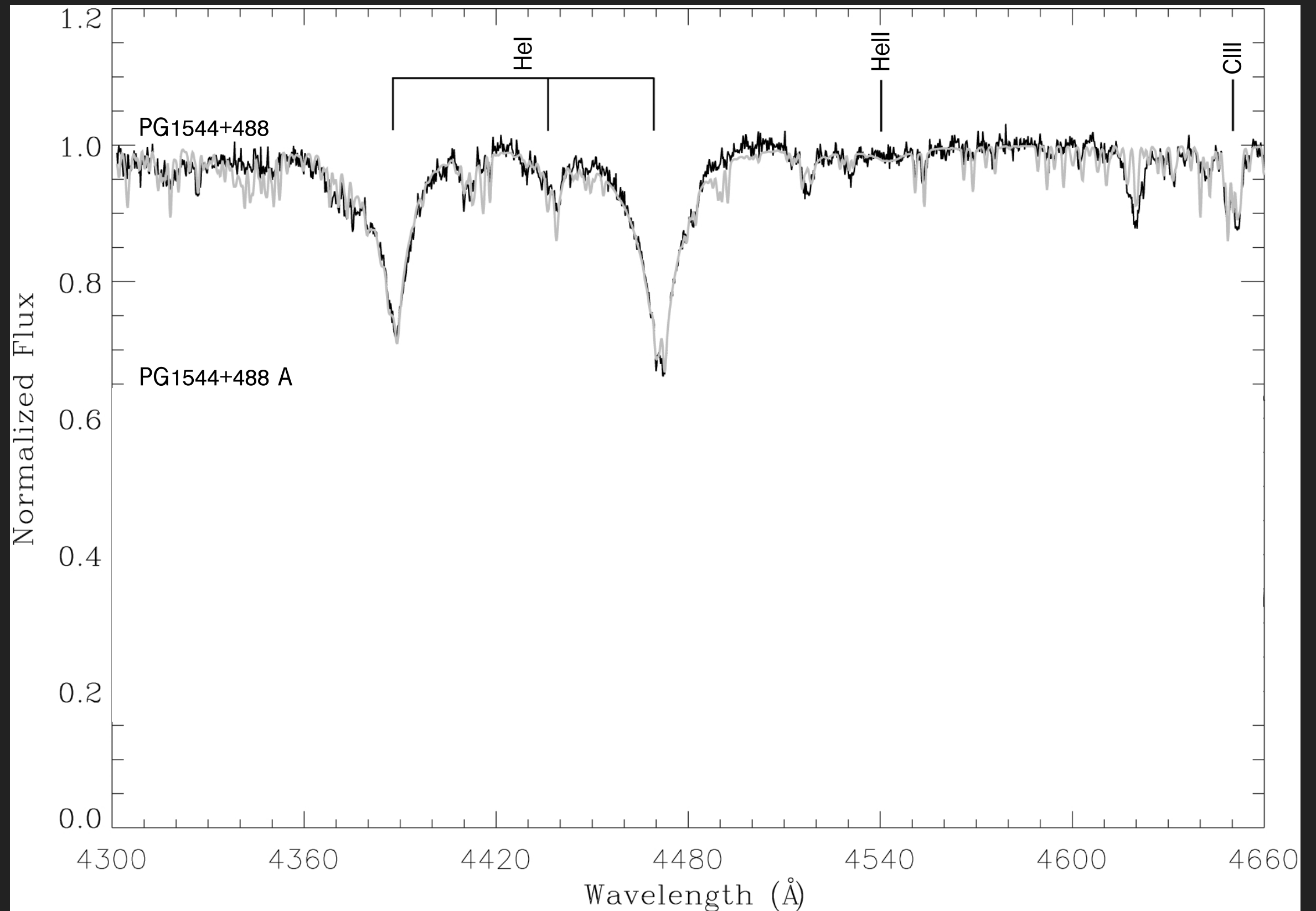


Lick Observatory



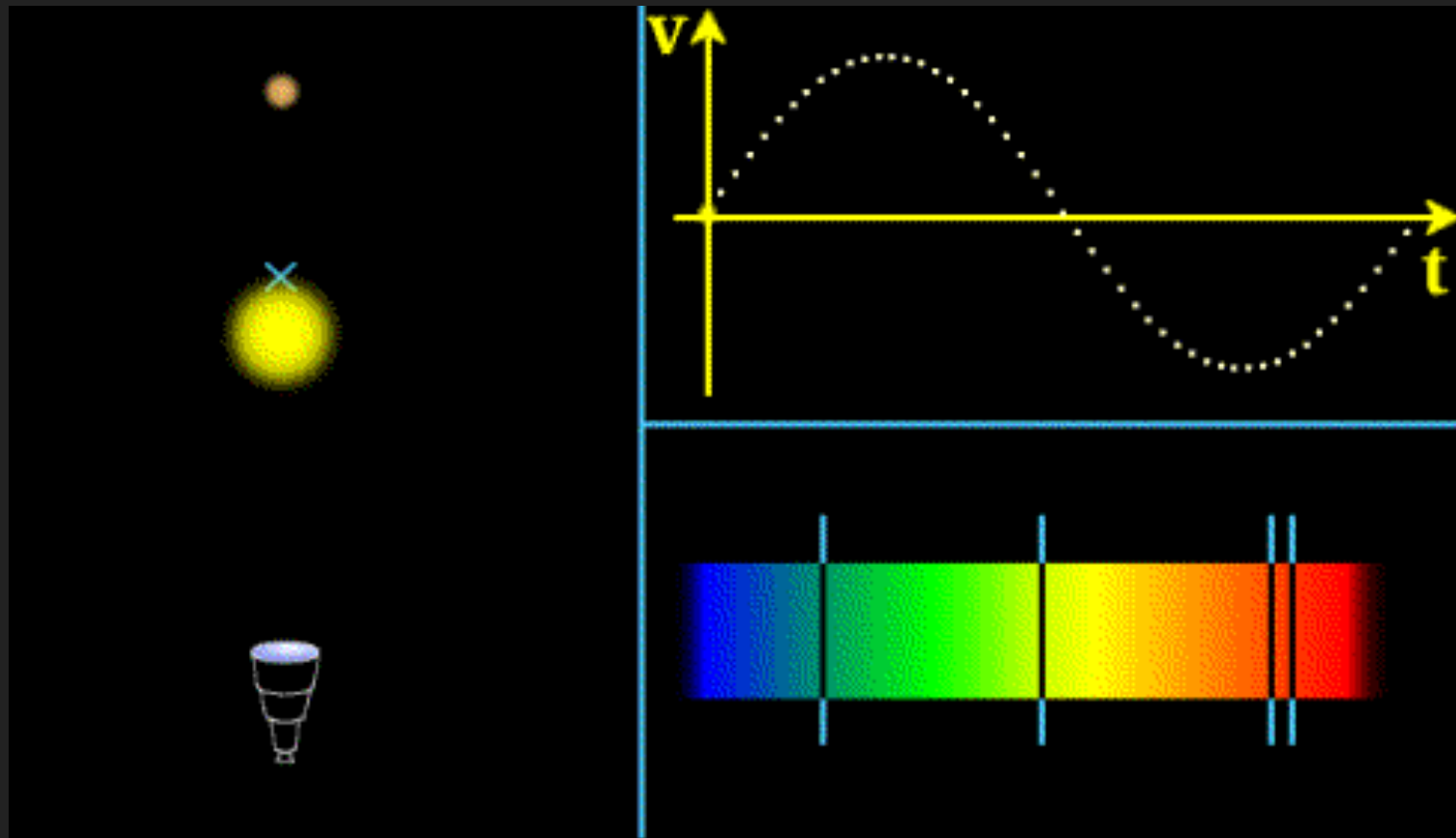


# SPECTROSCOPIC BINARIES



# DOPPLER EFFECT

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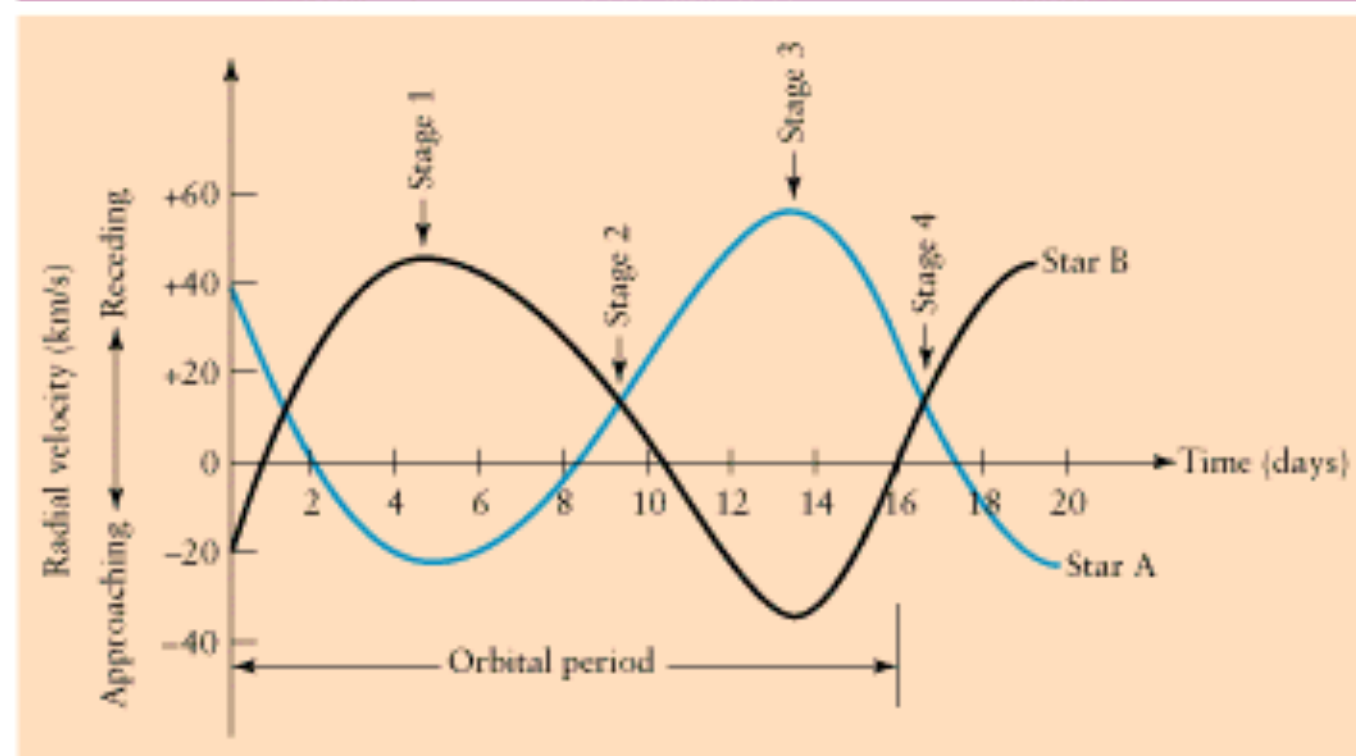
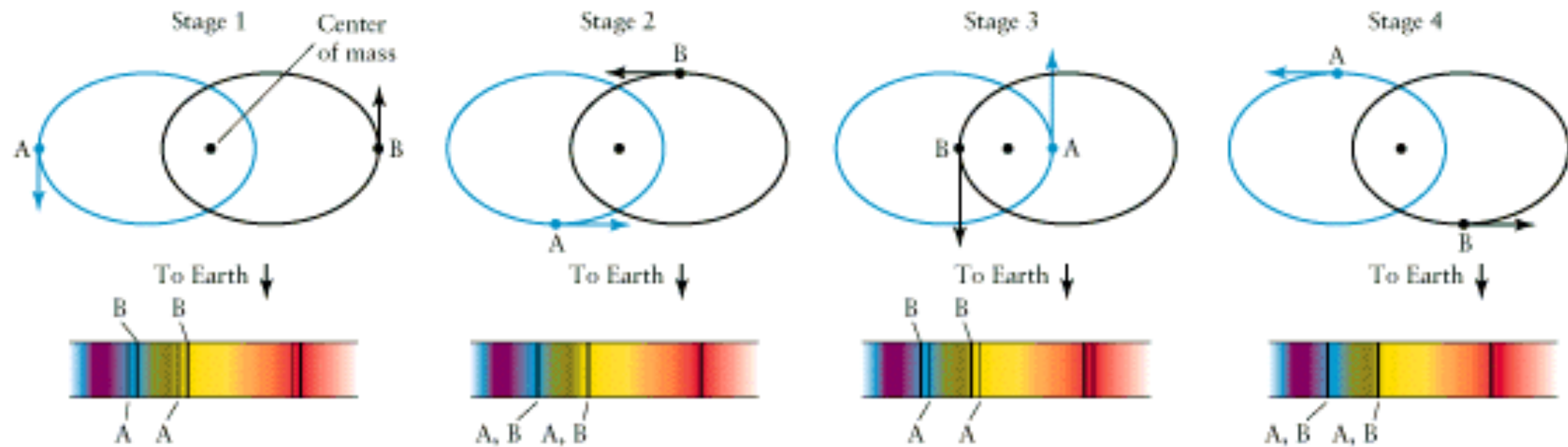


$$\frac{\Delta \lambda}{\lambda} = \frac{v}{c}$$

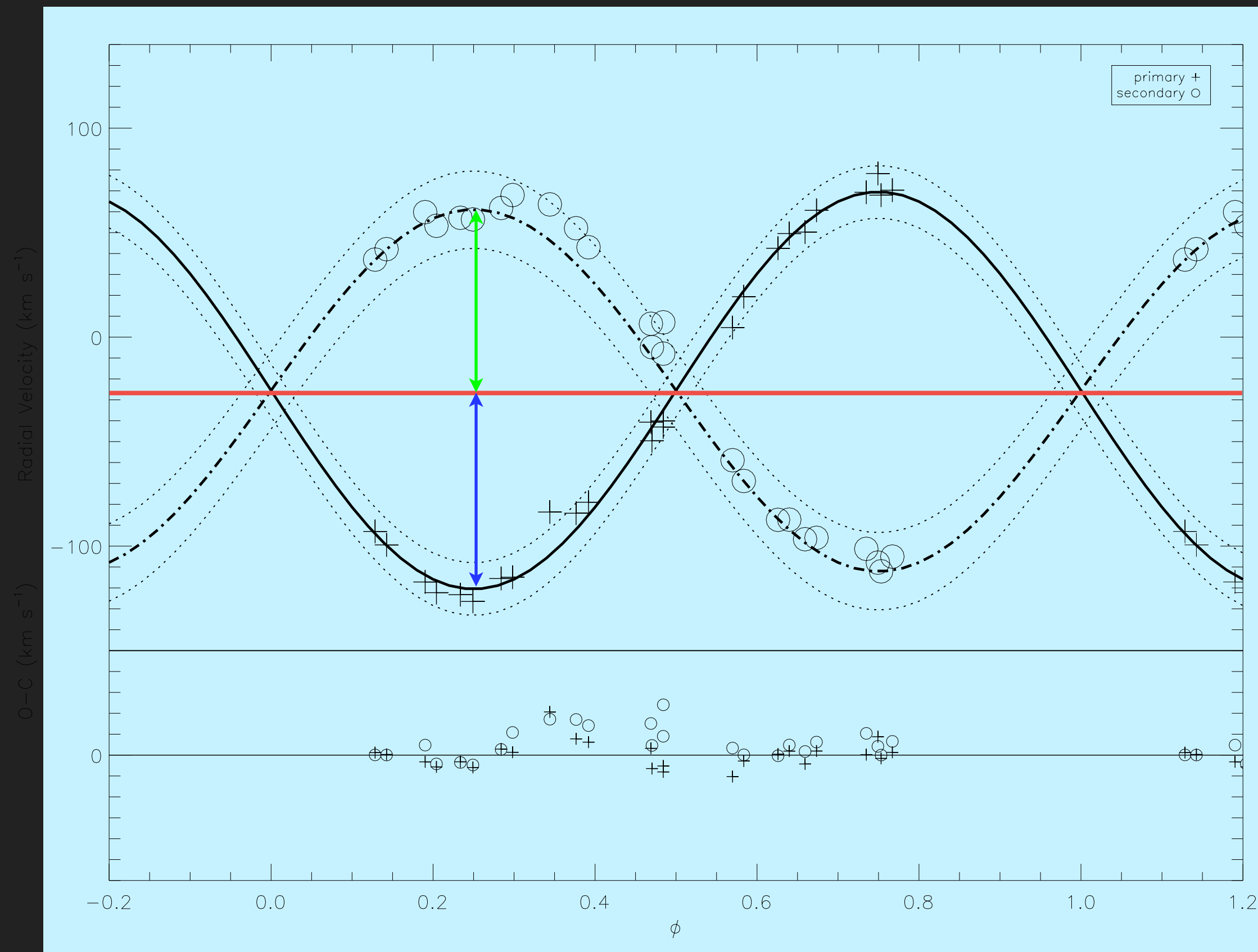
Approaching

Receding

# RADIAL VELOCITY CHANGE



# RADYAL VELOCITY CURVE





# REFERENCES

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- ▶ [https://www.researchgate.net/publication/228588773\\_New\\_Light\\_Curve\\_Analysis\\_for\\_Large\\_Numbers\\_of\\_Eclipsing\\_Binaries\\_I\\_Detached\\_and\\_Semi-Detached\\_Binaries](https://www.researchgate.net/publication/228588773_New_Light_Curve_Analysis_for_Large_Numbers_of_Eclipsing_Binaries_I_Detached_and_Semi-Detached_Binaries)
- ▶ <http://astro.physics.uiowa.edu/ITU/labs/professional-labs/eclipsing-binary-stars/advanced-instruments.html>
- ▶ <http://plato.acadiau.ca/courses/phys/1523/jan18/JAN18.HTM>
- ▶ Fundamental Astronomy, by Hannu Karttunen, Pekka Kröger, Heikki Oja, et al, 6th edition, Springer, 2017