Benchmarking Substellar Evolutionary Models Using New Age Estimates for HD 4747 B and HD 19467 B

Charlotte Wood

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Submitted!

Benchmarking Substellar Evolutionary Models Using New Age Estimates for HD 4747 B and HD 19467 B

Charlotte M. Wood,[1] Tabetha Boyajian,[2] Kaspar von Braun,[3] John M. Brewer,[4,5] Justin R. Crepp,[1] Gail Schaefer,[6] Arthur Adams,[4] and Timothy R. White[7]

[1] *University of Notre Dame, Department of Physics, 225 Nieuwland Science Hall, Notre Dame, IN 46556*

[2] *Louisiana State University, Department of Physics and Astronomy, 202 Nicholson Hall, Baton Rouge, LA 70803*

[3] *Lowell Observatory, 1400 W Mars Hill Rd, Flagstaff, AZ 86001*

[4] *Yale University, Department of Astronomy, P.O. Box 208101, New Haven, CT 06520*

[5] *Columbia University, Department of Astronomy, Mail Code 5246, 550 West 120th Street, New York, NY 10027*

[6] *The CHARA Array of Georgia State University, Mount Wilson, CA 91023*

[7] *Stellar Astrophysics Centre, Department of Physics and Astronomy, Aarhus University, Ny Munkegade 120, DK-8000 Aarhus C, Denmark*

Submitted to ApJ

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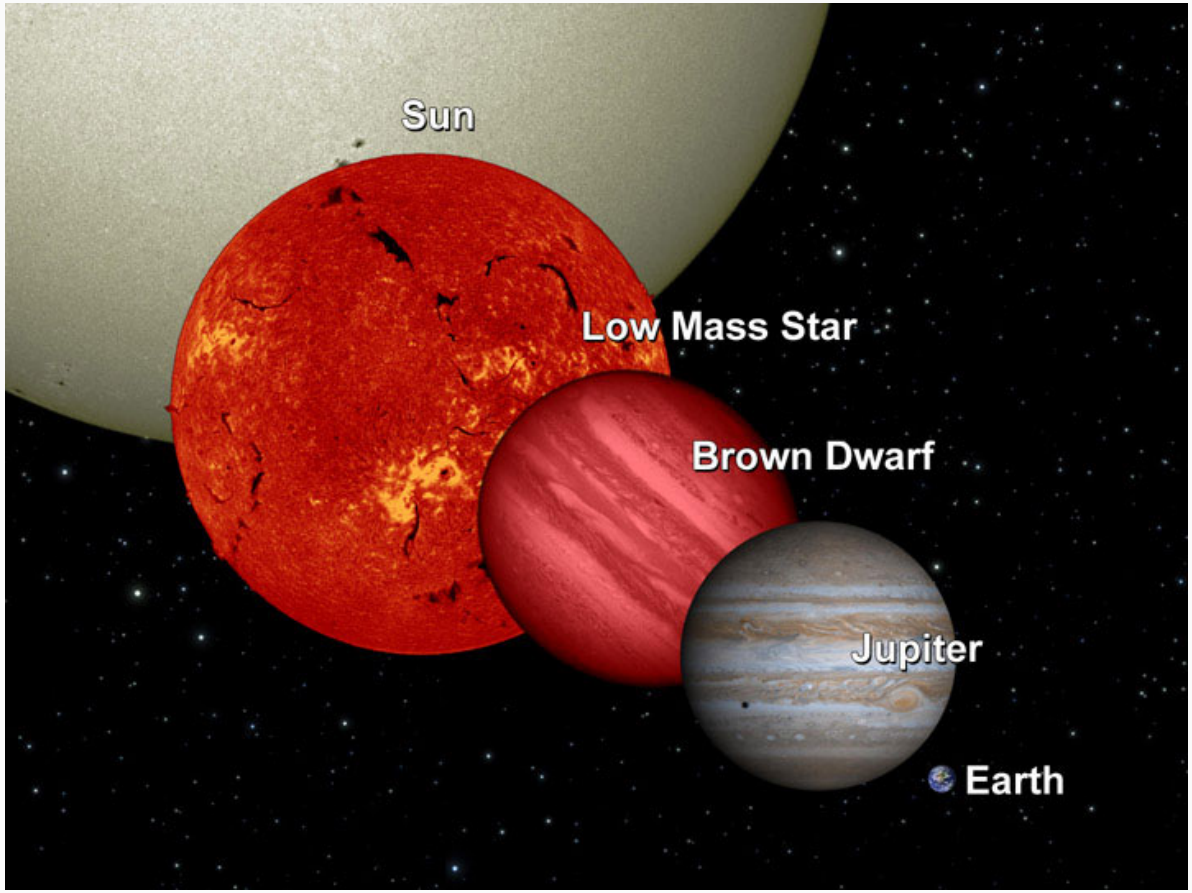
Introduction and Motivation

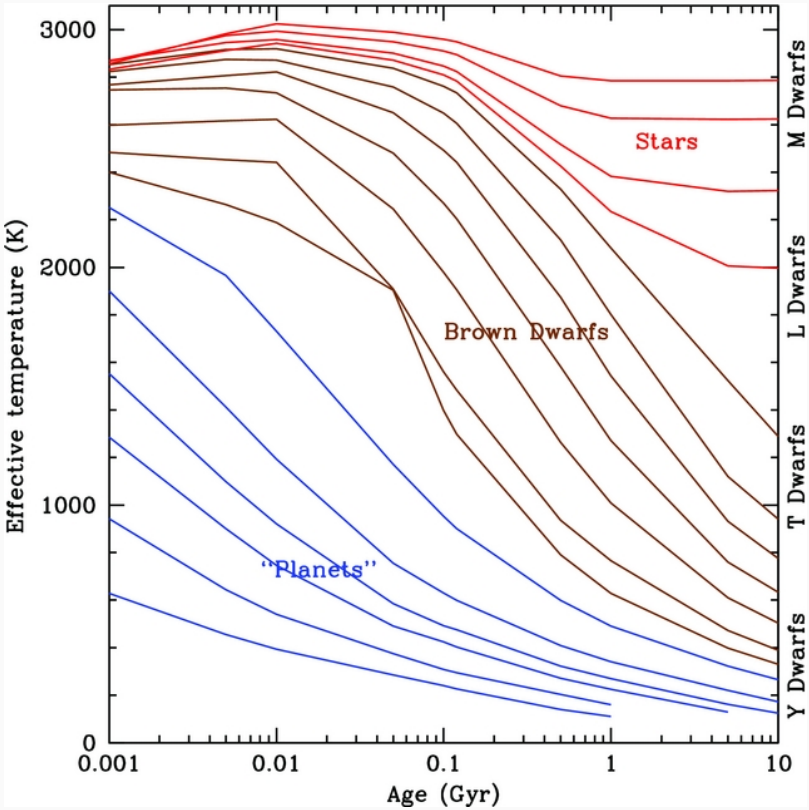
Not a Star and Not a Planet

- A brown dwarf is an object that does not sustain nuclear fusion
- Generally considered "failed stars"
- Mass $\sim 13 - 72\ \mathrm{M_{Jup}}$



Credit: Wikipedia

Brown Dwarfs Continuously Cool



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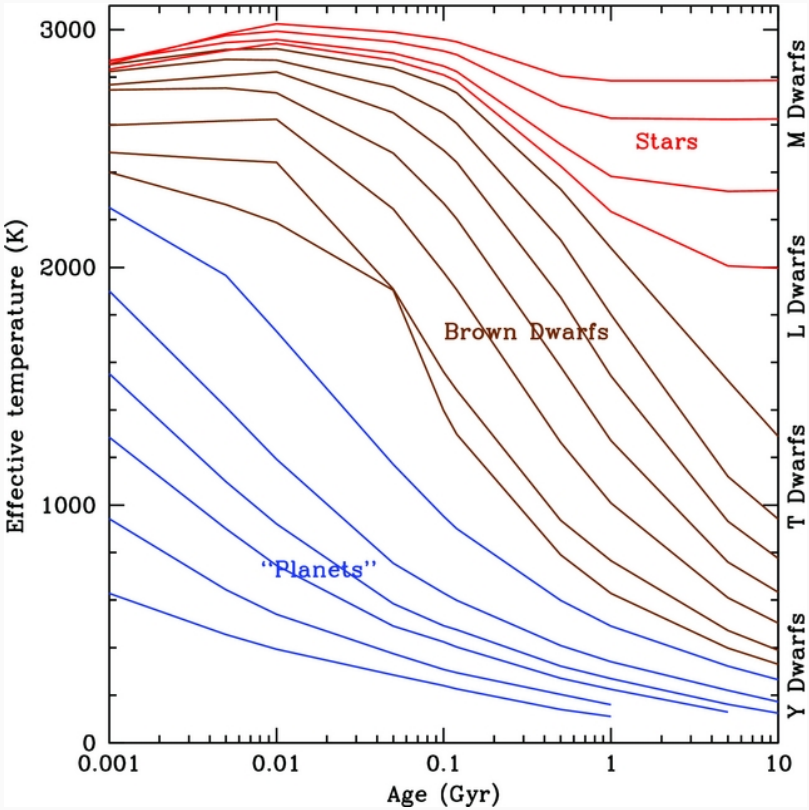

- Larger mass $\rightarrow$ hotter $\rightarrow$ higher luminosity

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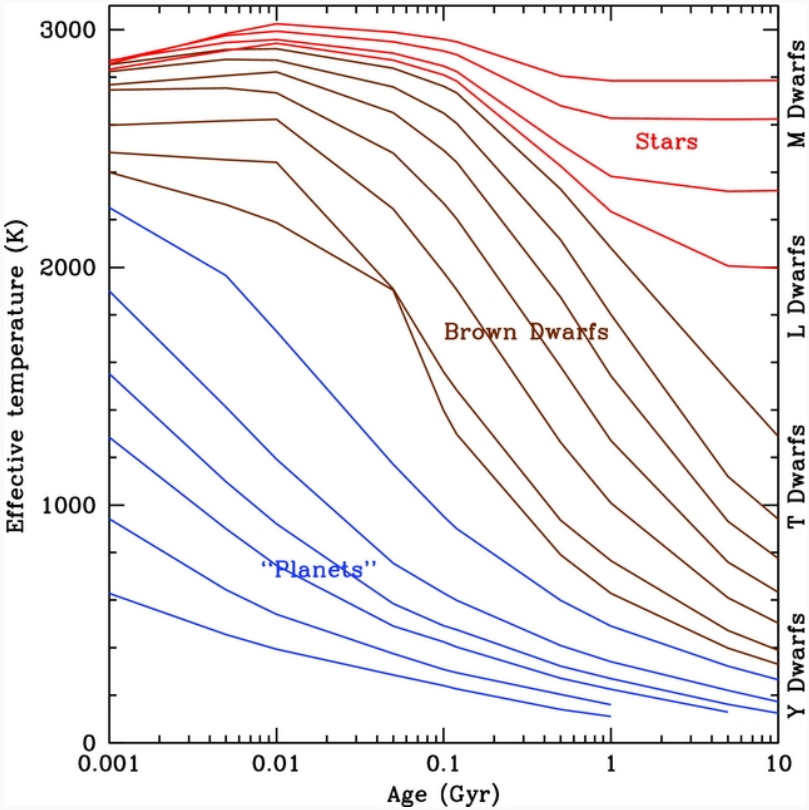

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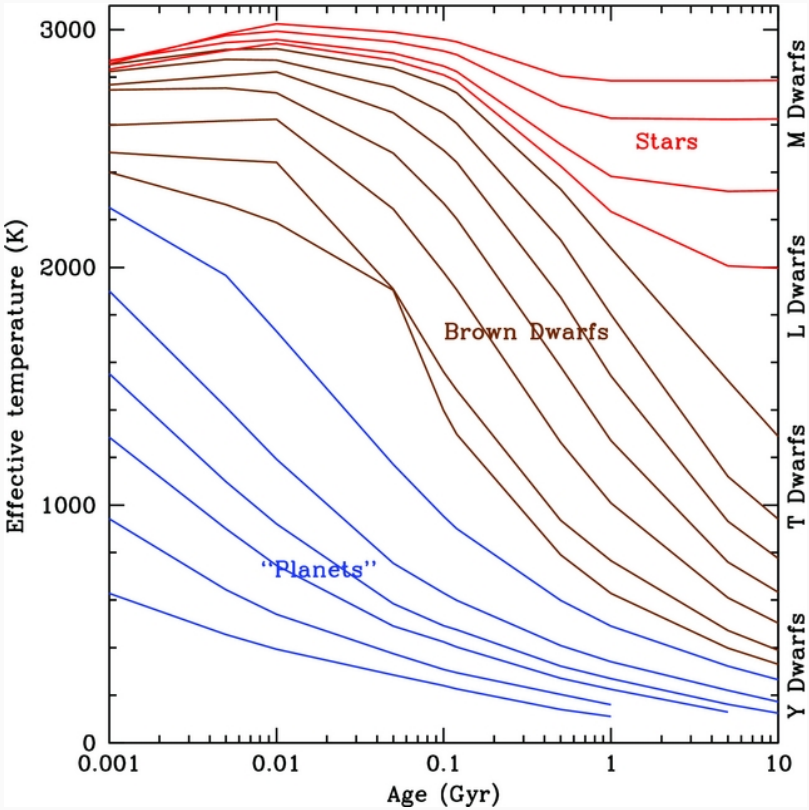

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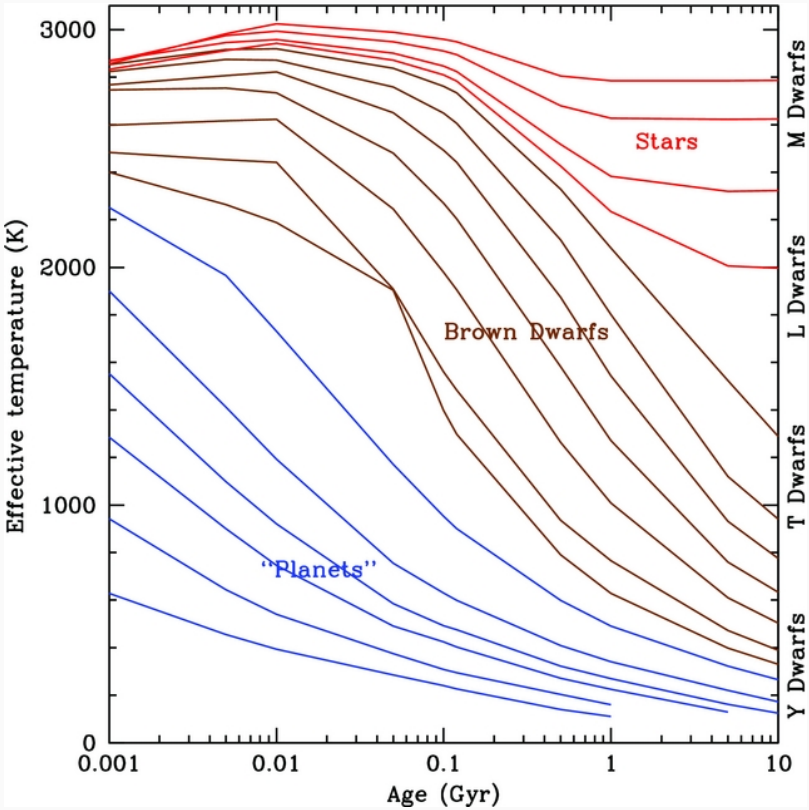


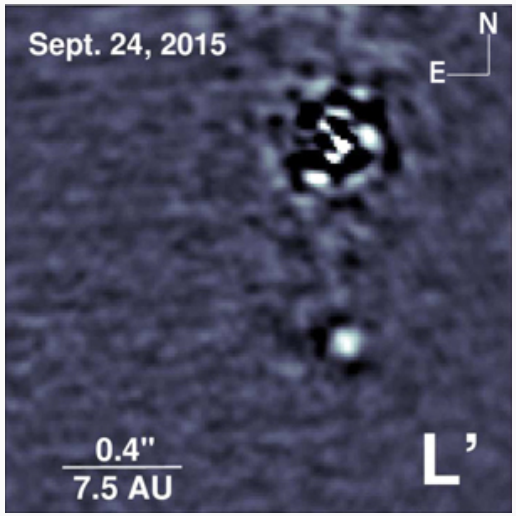
- Larger mass $\rightarrow$ hotter $\rightarrow$ higher luminosity
- Older age $\rightarrow$ lower luminosity
- Need three parameters: mass, age, and luminosity
- How do you determine if a brown dwarf is massive but old or light but young?

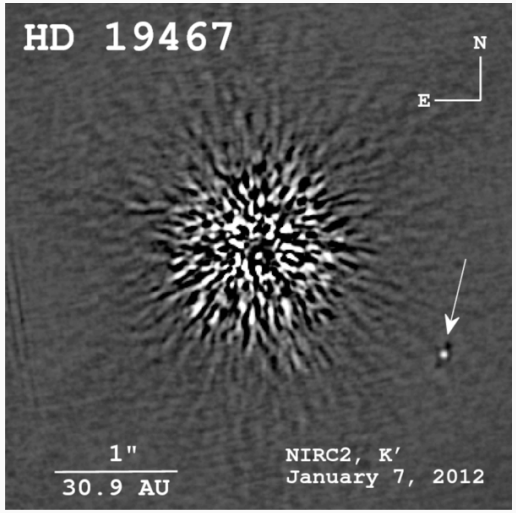
Credit: Bailey, J.

The Problem

Are the models actually any good?

Finding "Benchmark" Objects





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Credit: Crepp, J.

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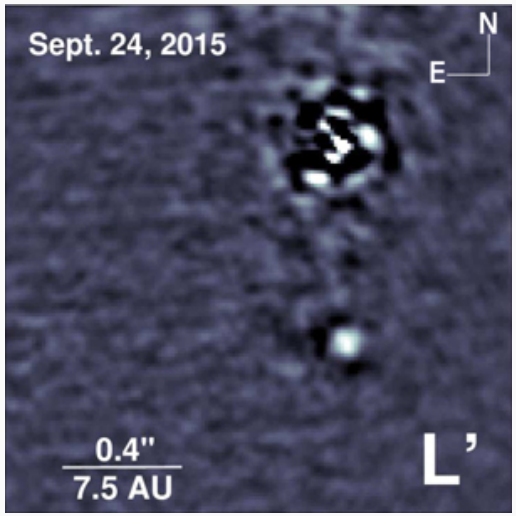
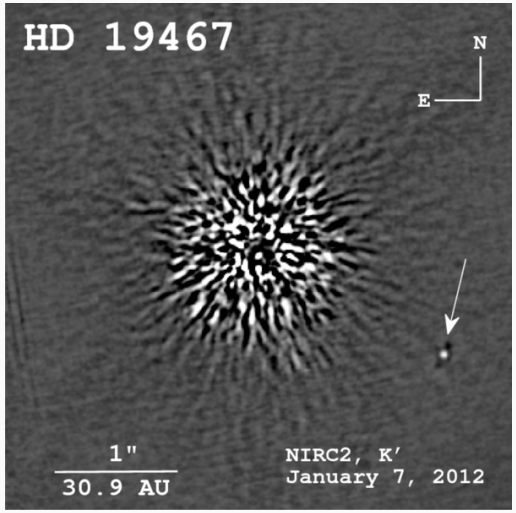




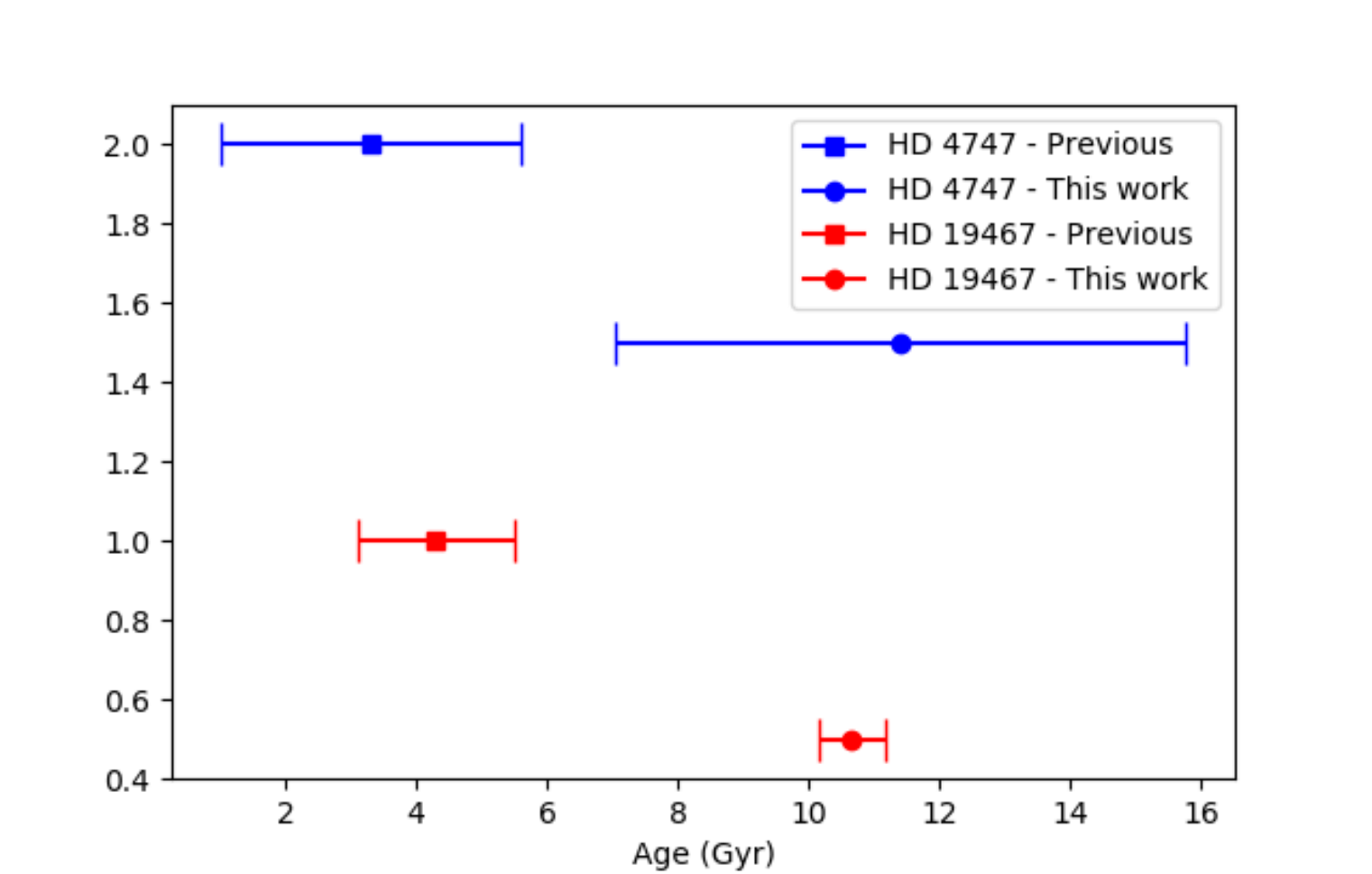
- Directly imaged brown dwarfs in binary (or higher) systems have model-independent masses, ages, and luminosities
- Use these "benchmark" brown dwarfs to test and calibrate models

Credit: Crepp, J.

Observations and Results

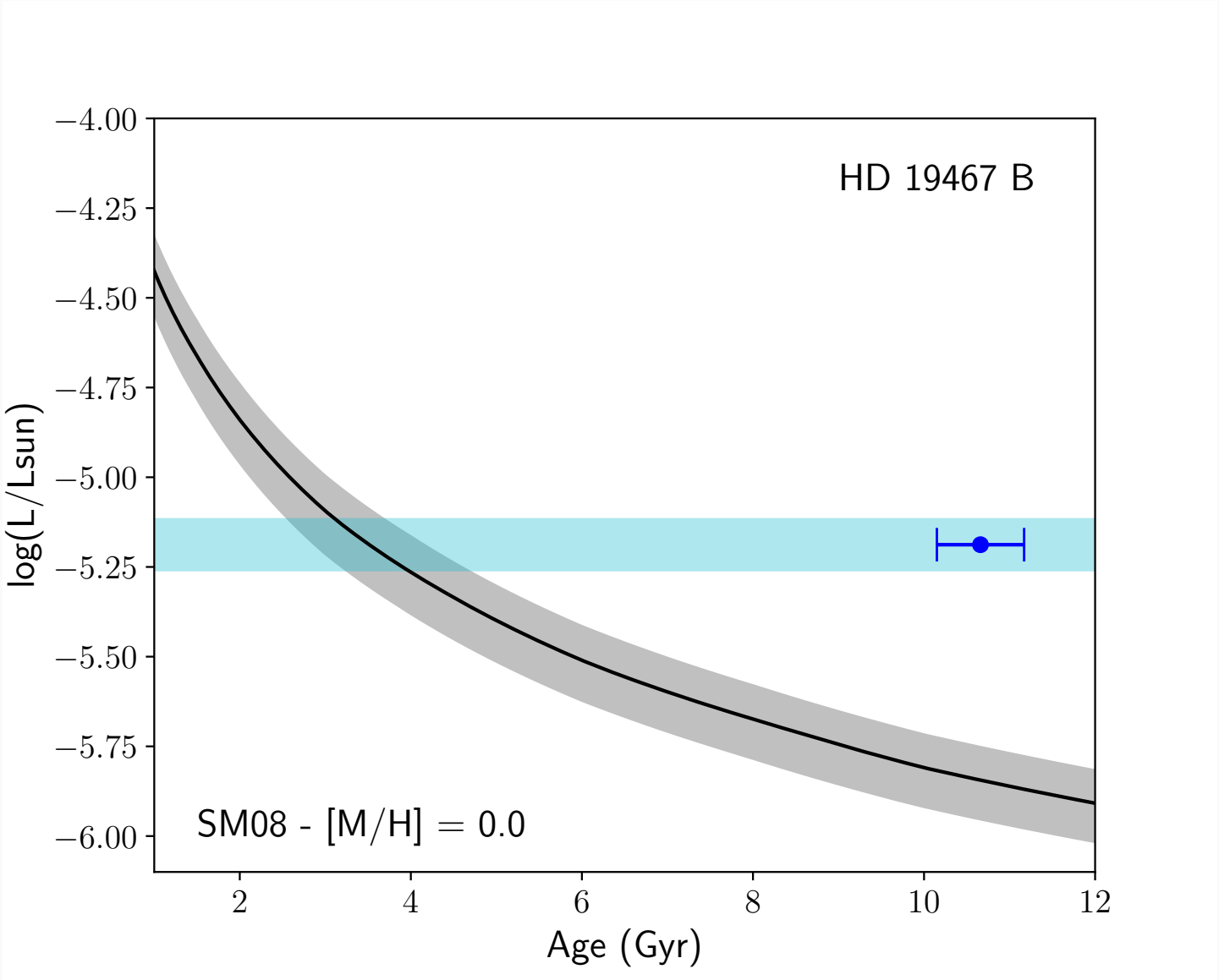
Study the Host Star Instead

Stellar models are more rigorously tested than brown dwarf models, but age results depend on method used.



Credit: Wood, C.

Comparing the Luminosities



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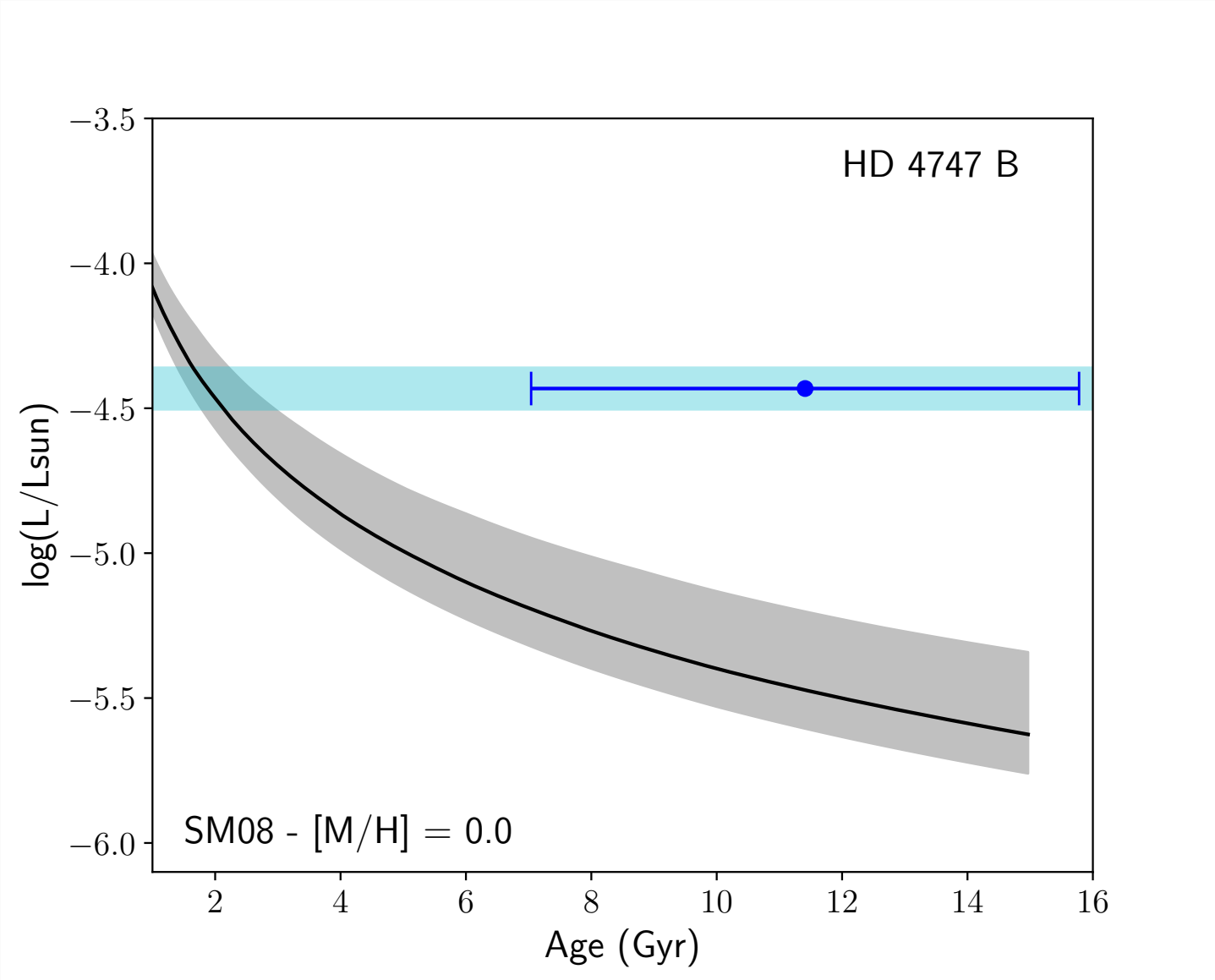
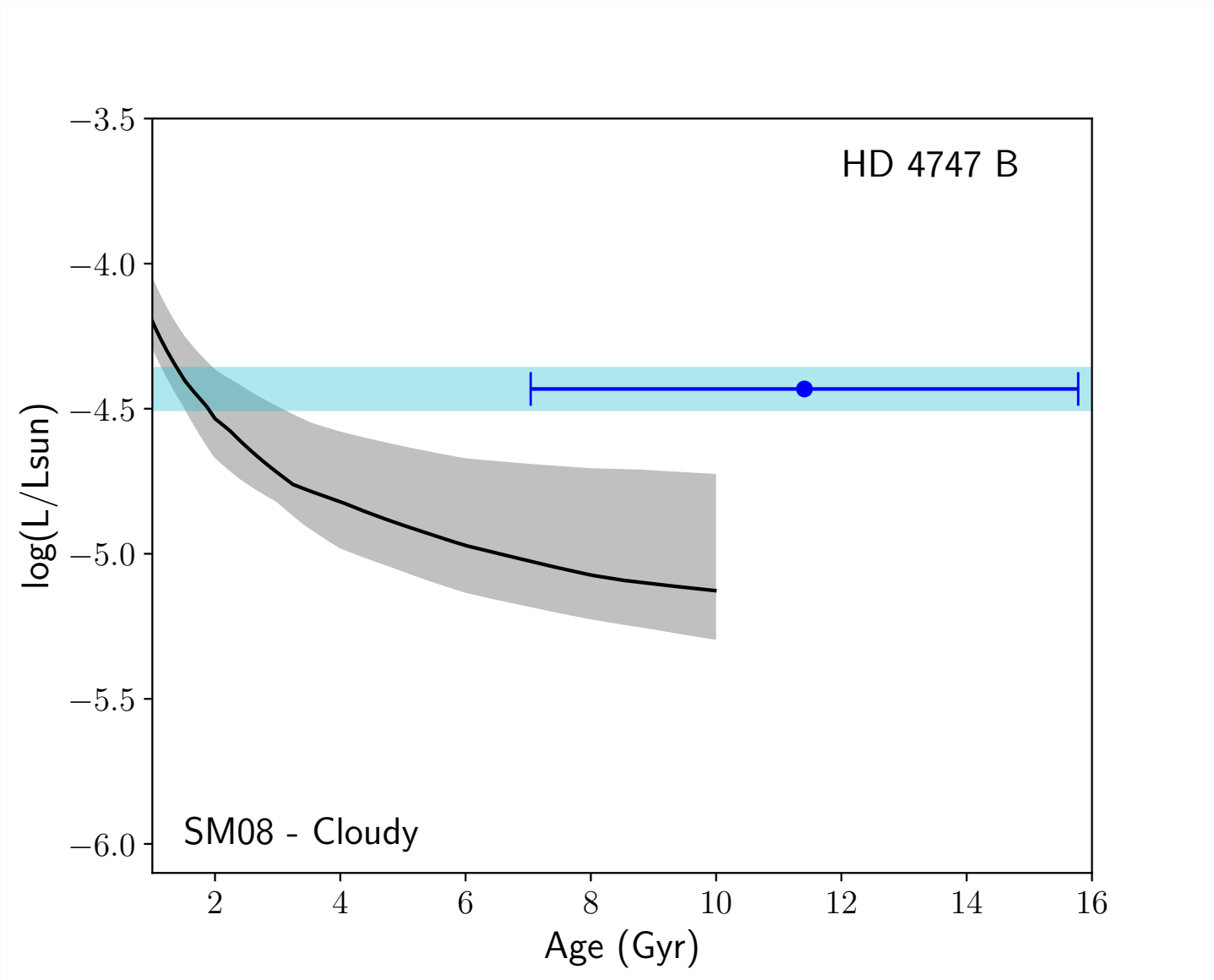


Credit: Wood, C.

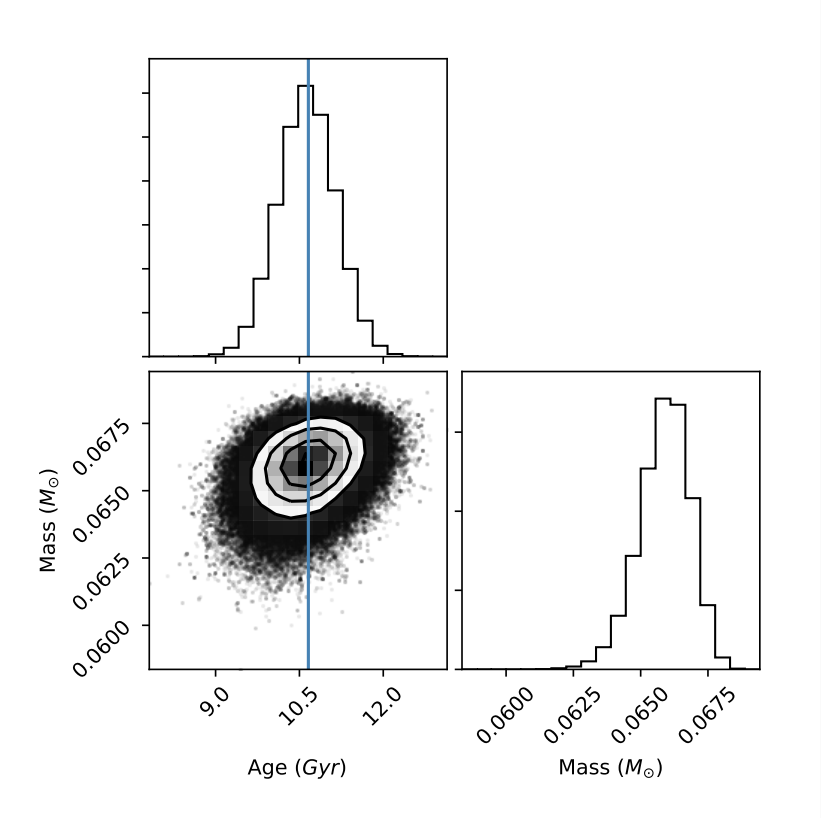
HD 4747 B Might Have Clouds



Credit: Wood, C.

Comparing the Masses

- Models come in form of a grid - each (mass, age) pair has a corresponding luminosity
- Explore the parameter space in an unbiased way using a Markov Chain Monte Carlo simulation
- Returns a probability distribution for the explored parameter



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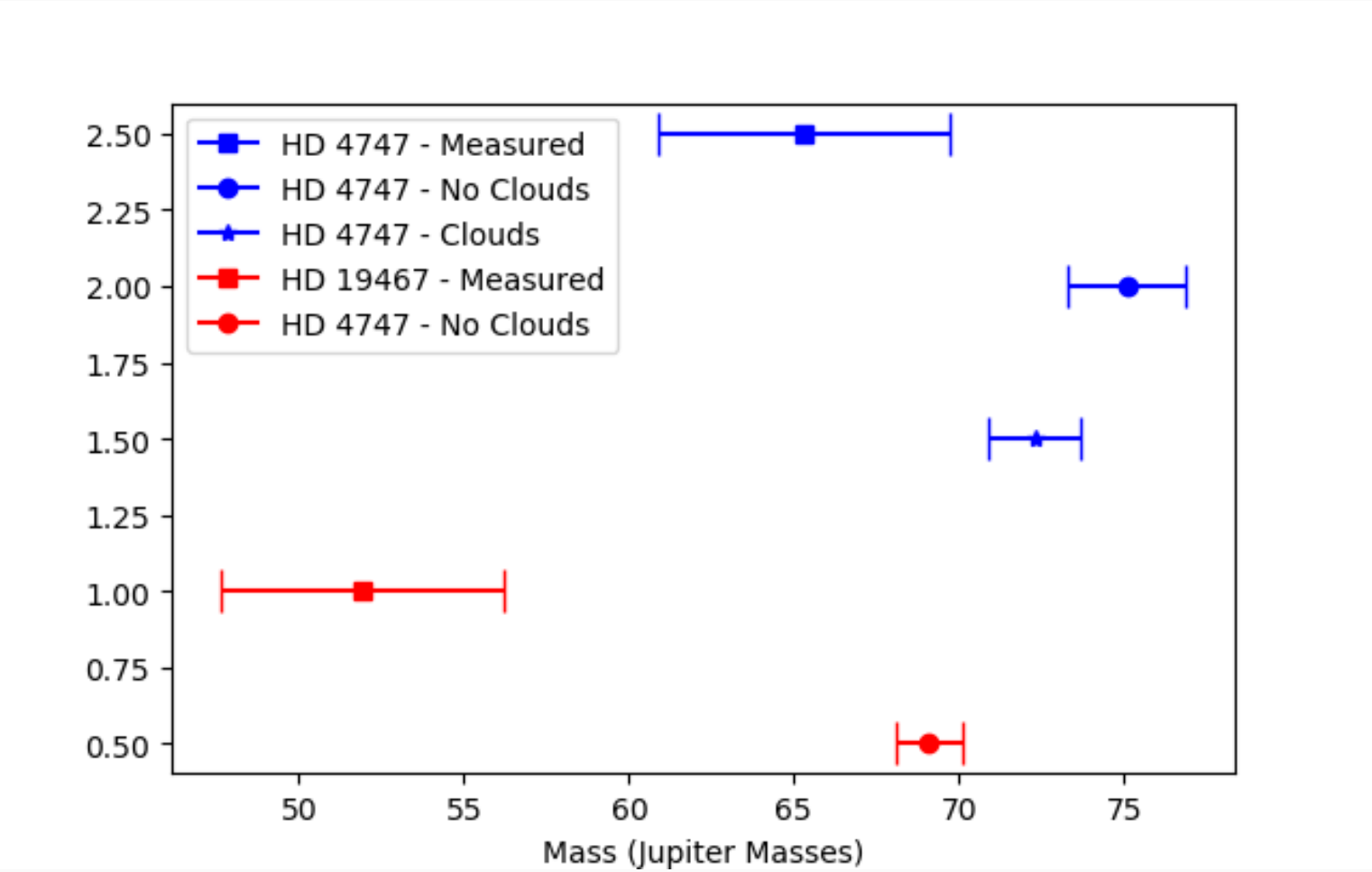

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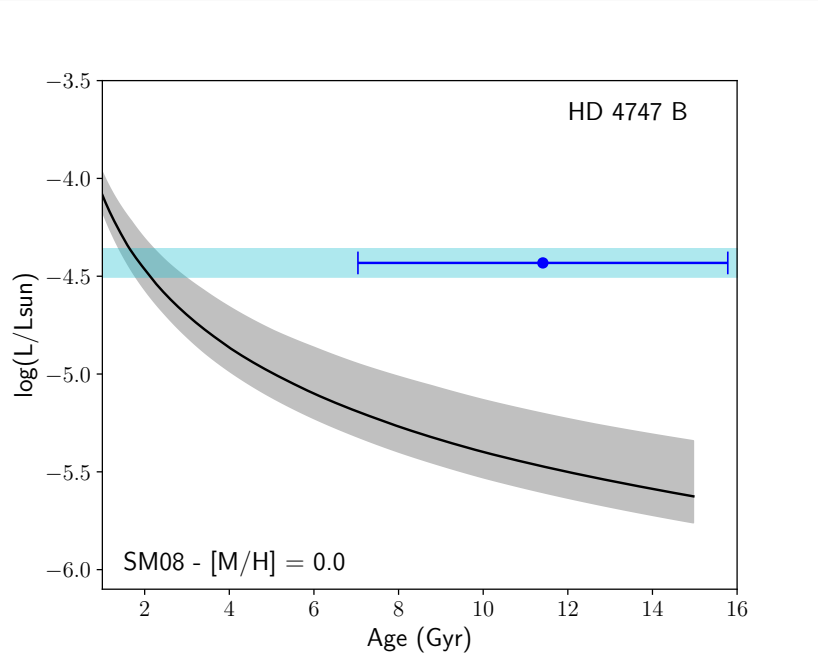
Conclusions

Conclusions & Future Work



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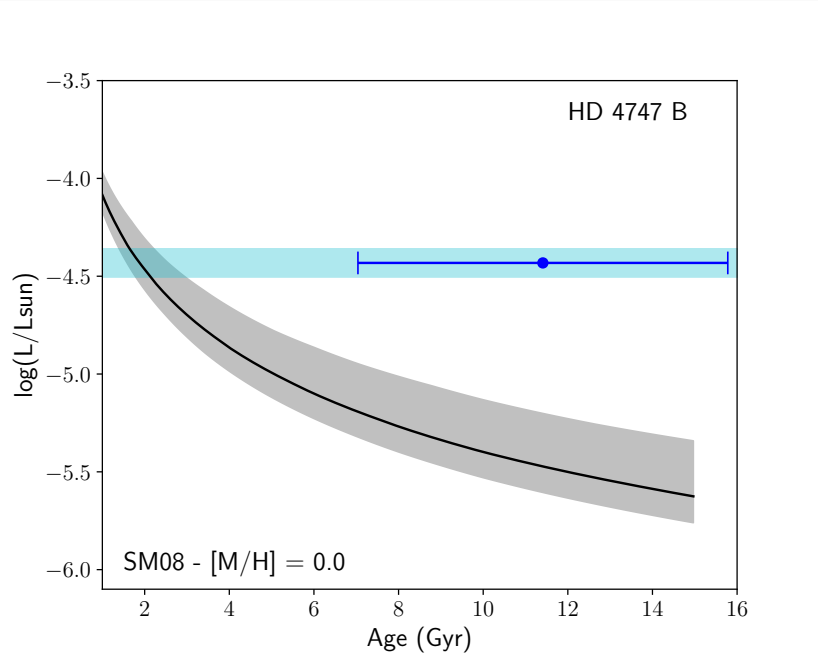

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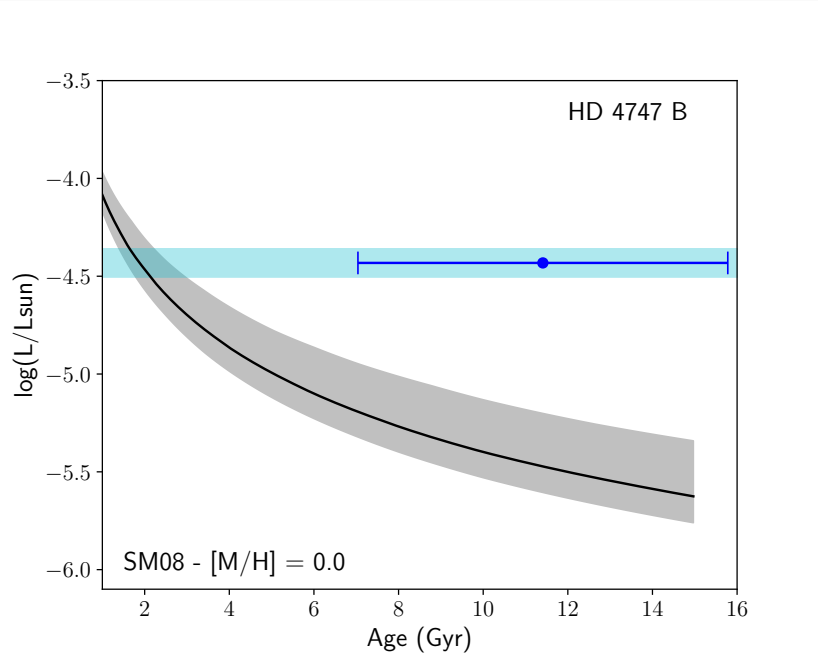

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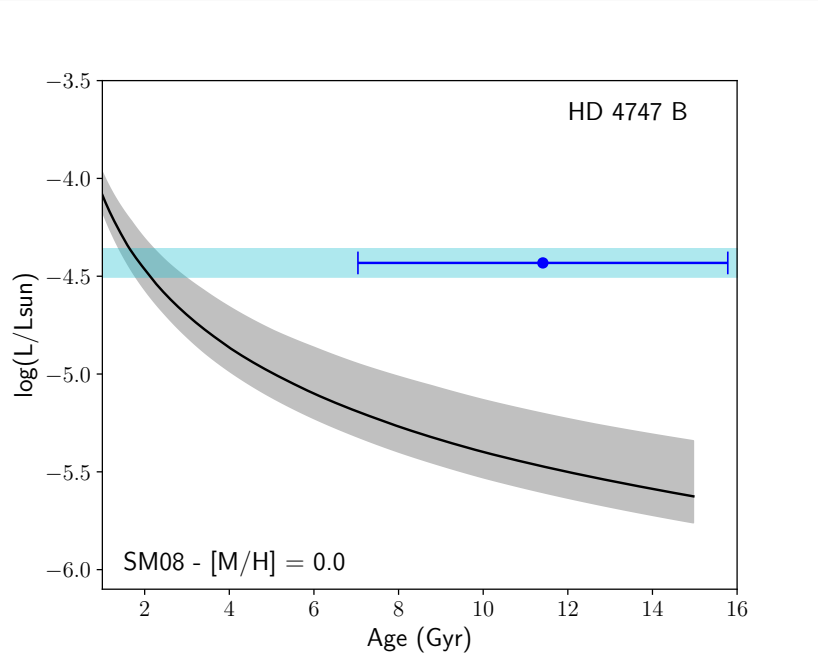

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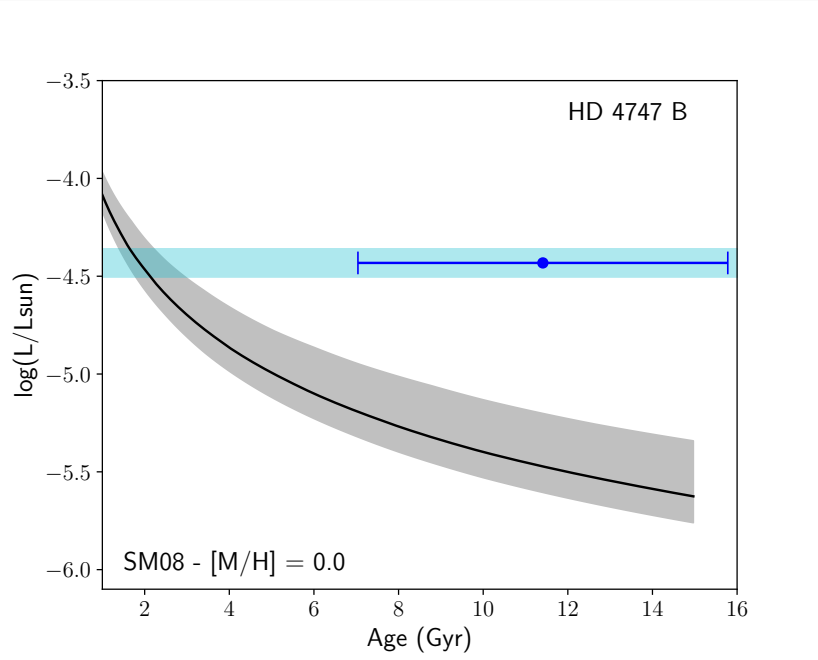

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Questions?