The Stability and Compactness of Two-Scalar Boson Stars

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What are two-scalar boson stars?

Definition:

A ***two-scalar boson star*** *is a star composed of two different types of scalar bosons.*

Are boson stars boring?

- No boson stars have been discovered yet.
- Discovering boson stars might lead to the discovery of new particles.

How can we find boson stars?

- Boson stars might be transparent.*
- Traditional methods have not been able to find boson stars.
- But gravitational wave detectors provide new way to search for boson stars.

*F. E. Schunck and E. W. Mielke, “General relativistic boson stars,” Class. Quant. Grav. 20 (2003) R301–R356, arXiv:0801.0307 [astro-ph].

How does my project fit in?

- We want to know what kind of gravitational waves would be emitted by a boson star.
- Specifically, we studied boson stars in extreme mass ratio inspirals.

What do we need to do?

To do the gravitational wave calculations, we need to know three things:

- What kinds of boson star configurations are possible?
- Which configurations are stable?
- How compact is each configuration?

What configurations are possible?

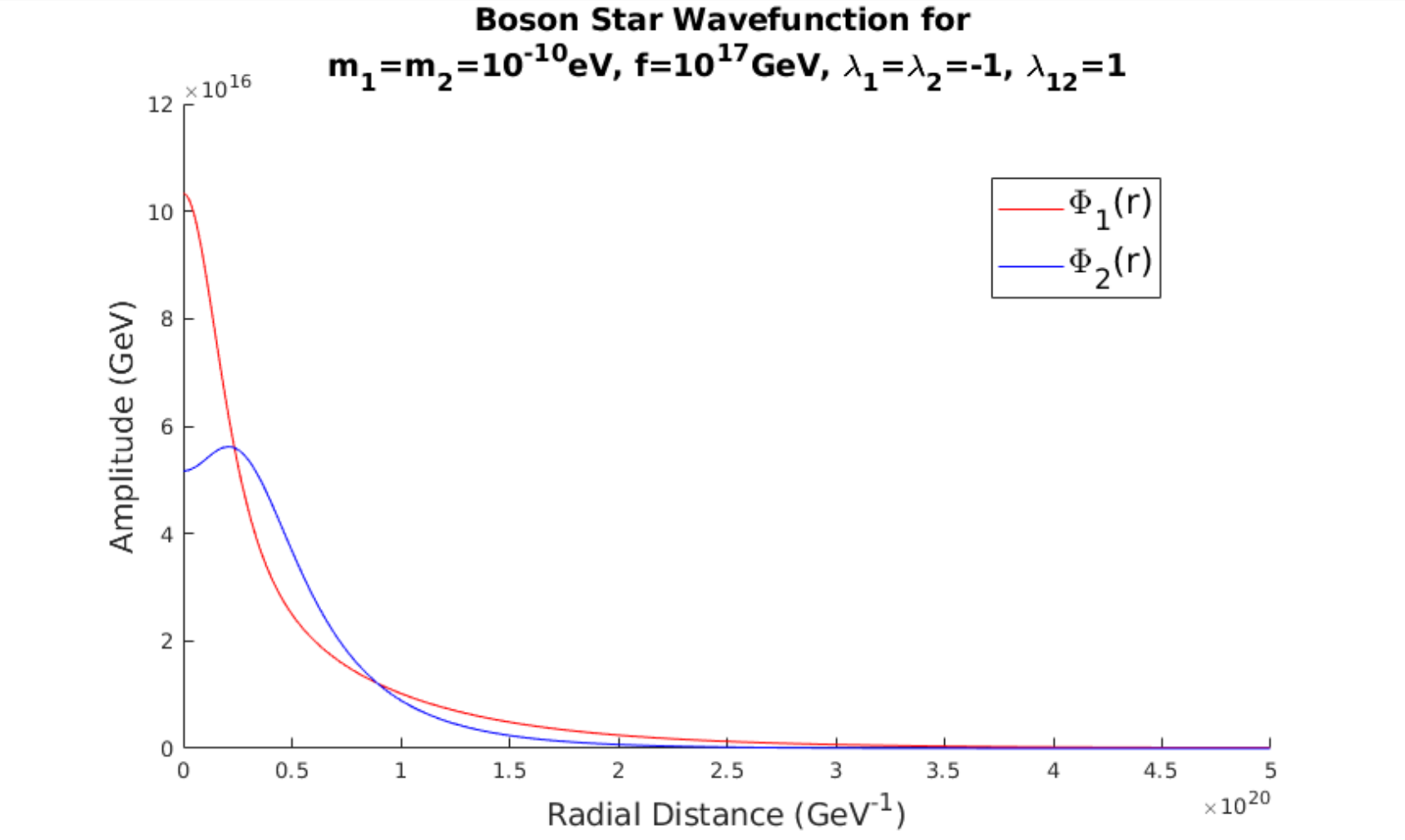
To find possible configurations, we need to solve:

- the Einstein field equations and
- the Klein-Gordon equations

Additionally, we only want physically reasonable solutions:

- Space-time should be flat far from the star
- The solution should have rotational symmetry
- We only want the ground-state solutions

Example Solution



Which configurations are stable?

To find stable configurations, we need to:

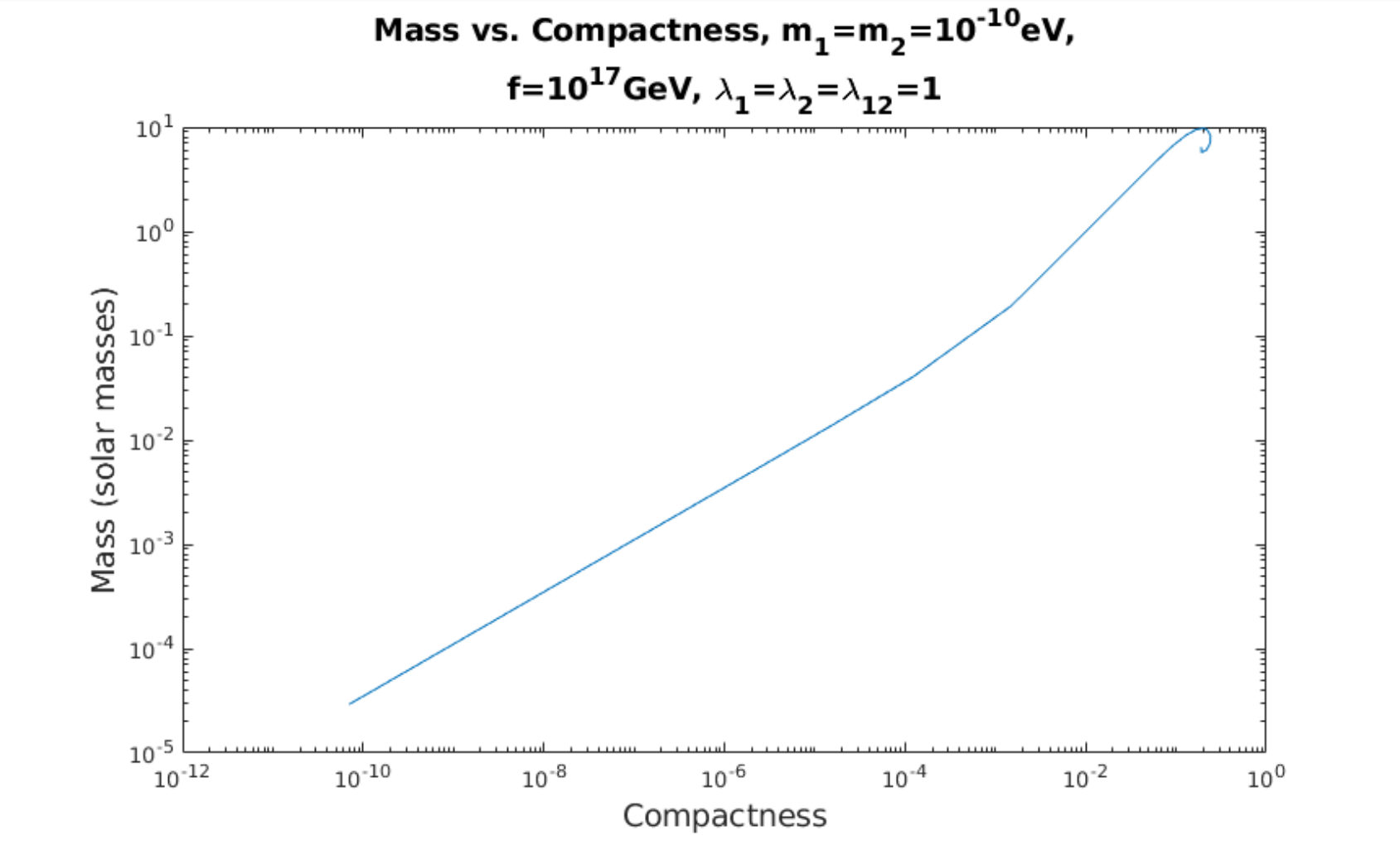
- find an energy eigenstate solution,
- perturb it slightly, and
- evolve the perturbed solution forward in time

Which configurations are stable?

To evolve the solution forward:

- solve the Klein-Gordon equations for $\phi(r, t)$ after a small time step,
- solve the Einstein field equations for the new metric components,
- repeat

How compact is each configuration?



How compact is each configuration?