Why Isothermal Bonnor-Ebert Spheres MUST Collapse; A 3-D AMR study using AstroBEAR2.0

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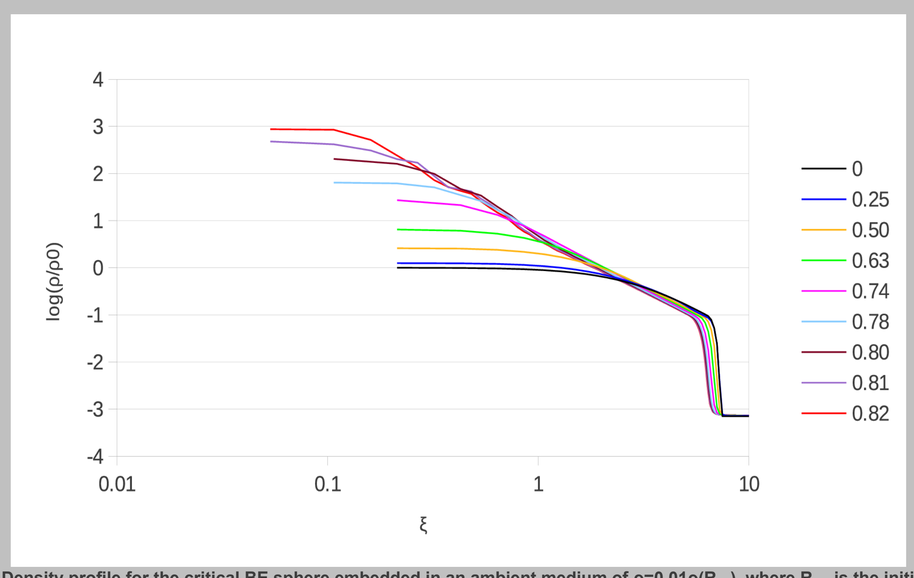
ABSTRACT

The ambient medium of a Bonnor-Ebert (BE) sphere is very important in determining stability of the sphere.

Traditional collapse studies of BE spheres force collapse with a perturbation.



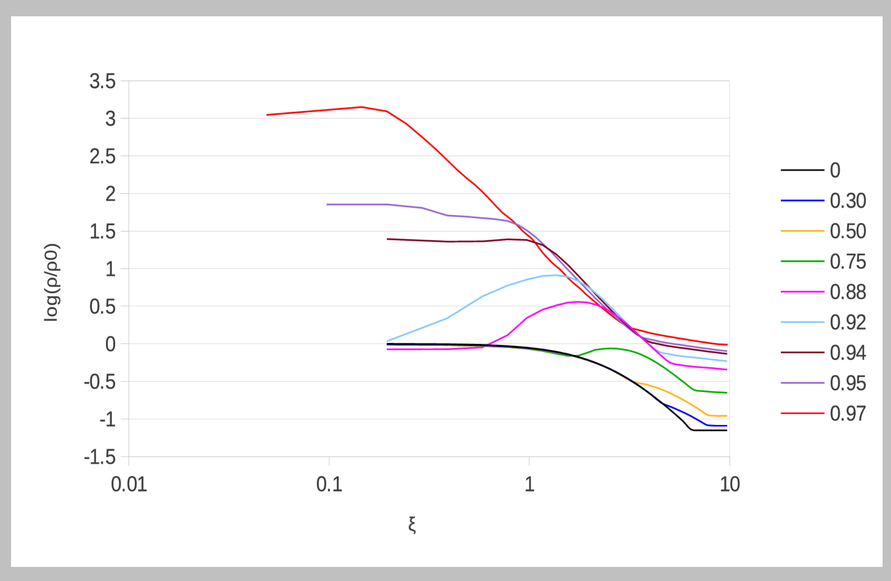
Density profile for the critical BE sphere embedded in an ambient medium of ρ=0.01ρ(R_{BE}), where R_{BE} is the initial Bonnor-Ebert radius, and perturbed into collapse with a 10% over-density. The x-axis is in units of non-dimensional radius,$\xi=r(4\pi G\rho_0)^{1/2}/C_s$ (ρ_0 is initial central density, C_s^2 is the isothermal sound speed). Time is in units of the sphere's sound crossing time.

RESULTS

We find the choice of ambient medium matters greatly whether the (critical) BE sphere collapses.

Without applying a perturbation, the ambient alone is sufficient in triggering collapse in all but the sparsest of cases

This collapse begins with a compression wave phase and terminates with a traditional outside-in phase.



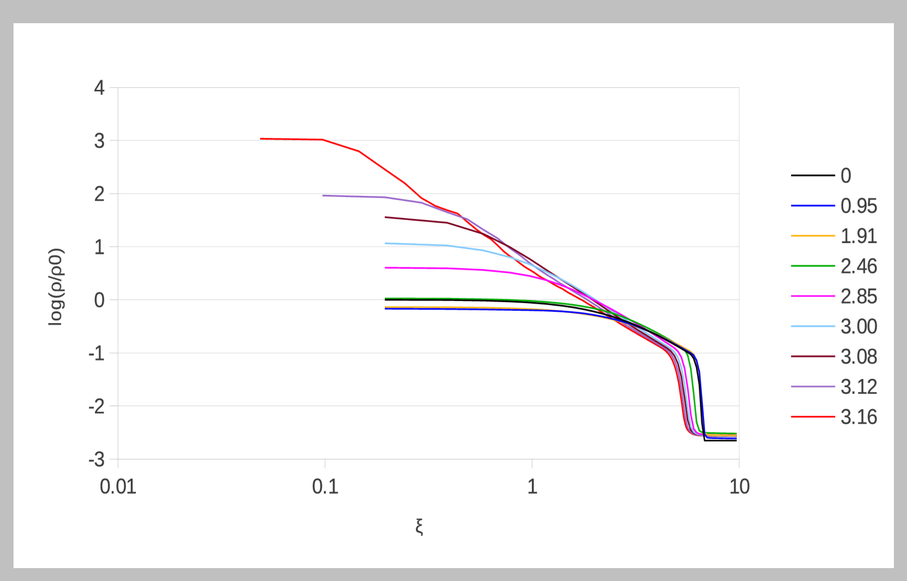
Density profile for the critical BE sphere embedded in an ambient medium of ρ=ρ(R_{BE}). The ambient collapses under its self-gravity, inducing a compression wave that travels inward, destabilizing the sphere. Classic outside-in collapse then proceeds.

But, embedding the sphere in a continuous environment causes a collapse of its own.

Bonnor-Ebert spheres are possible protostar candidates

– e.g. B68 –

Placing sphere in a sparser ambient still leads to collapse, but of a different nature.



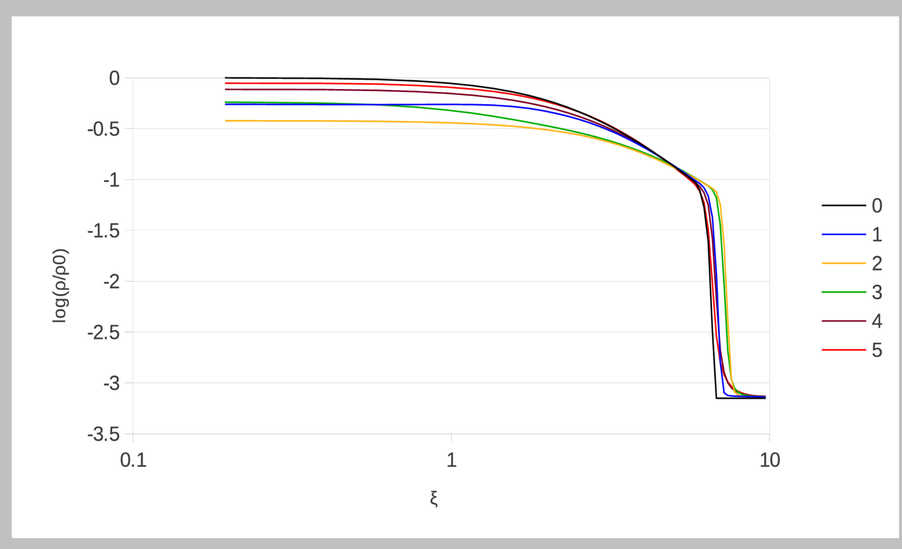
Density profile for the critical BE sphere embedded in an ambient medium of ρ=1/3ρ(R_{BE}). A mild redistribution of material renders the sphere unstable and it collapses in the Classic outside-in manner.

CONCLUSIONS

1. Isothermal BE spheres are not long-lived structures.

2. BE spheres in two-temperature systems can be long-lived.

3. Perturbed BE spheres collapse similarly to non-perturbed spheres in light enough environments.



When the ambient is made sparse enough, the sphere oscillates stably.

Density profile for the critical BE sphere embedded in an ambient medium of ρ=0.01ρ(R_{BE}). With no perturbation, the sphere oscillates stably around its equilibrium values.

REFERENCES: B68 paper, Bonnor Ebert papers, B&P?

ACKNOWLEDGMENTS: ?

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