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Research Note

Is Hercules X-1 a strange star?

Jes Madsen

Institute of Physics and Astronomy, University of Aarhus, DK-8000 Århus C, Denmark

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Abstract. The possible identification of Her X-1 with a strange star (Li et al. 1995) is shown to be incorrect.

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A recent *Letter* by Li et al. (1995) estimates a semiempirical mass-radius relation for the X-ray pulsar Her X-1 and compares it with models for neutron stars and strange stars. Based on this comparison, the authors conclude that "the strange star model is more consistent with Her X-1", and therefore "suggest it is a strange star".

Unfortunately this interesting conclusion is incorrect. As demonstrated by the authors, the concordance between the strange star models and the Her X-1 data occurs for a choice of bag constant $B^{1/4}$ in the range from 175–200 MeV, whereas a lower choice of bag constant gives models that are as inconsistent with the data as are the neutron star models used. However, strange quark matter is *unstable* for this range of parameters. For massless quarks and negligible strong coupling (as assumed by the authors), stability only occurs for $B^{1/4}$ in the range from 145–164 MeV (Farhi & Jaffe, 1984; Madsen, 1994). This means, that strange stars *cannot exist* for bag constants above 164 MeV, as erroneously assumed by the authors.

Using more realistic assumptions (like finite strange quark mass and non-zero strong coupling constant) will not improve the situation. A non-zero strong coupling constant, α_s, effectively corresponds to a lowering of the bag constant and keeping $\alpha_s = 0$. This would reduce all the numbers quoted for $B^{1/4}$ above, but there would still be a gap of more than 10 MeV between the lowest value of $B^{1/4}$ fitting Her X-1 and the highest value consistent with strange quark matter stability. A non-zero strange quark mass makes things even worse, because it leads to an even narrower interval of $B^{1/4}$ for stability (and possible strange star existence).

If the semiempirical mass-radius relation for Her X-1 derived by Li et al. is correct, there is indeed an interesting problem in interpreting it in terms of standard neutron star equations of state. But a strange star model does not fit either.

References

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