Astronomical and Astrophysical Transactions, 1998,
Vol. 15, pp. 165–166
Reprints available directly from the publisher
Photocopying permitted by license only

γ CAS AND ITS DISTANT COMPANION

I. N. LATYSHEV

Eurasian Astronomical Society, Moscow, Russia

(Received April 30, 1996)

It is shown that γ Cas (BOIVe) and HD 5408 (B9IVn) having similar μ and V_r form a very wide physical pair with an orbital period about 20×10^6 years. The parameters of the Hill's sphere are calculated, which show that this binary system is stable in the Hill's sense.

KEY WORDS **Stars: binary, distant companions, Hill's spheres**

Owing to the action of the regular and irregular gravitational fields of our Galaxy the mean lifetime of a binary stellar system with a total mass of about one solar mass and with a linear distance between its components of about 0.5 pc can be estimated as 10^9 years (Cruz-Gonzales and Poveda, 1971; Nezhinskij, 1971). The linear distance between components in the case of young massive stars can be more than 0.5 pc. I have made an attempt to find such binary systems.

The observational data (from the BS catalogue) on one such system γ Cas and HD 5408 are given in the Table 1.

Table 1.

Star	$\alpha 2000$	$\delta 2000$	$\mu\alpha$	$\mu\delta$	V_r	V	$B-V$	S_p
γ Cas	$0^h56^m42^s.4$	$+60°43'00''$	$+0''.025$	$+0''.000$	−7	2.47	−0.15	B0IVe
HD 5403	0 56 47.0	+60 21 46	0.032	−0.002	−5	5.55	−0.07	B9IVn

The angular distance between γ Cas and HD 5408, $d = 21$ arcmin. My method published earlier (Latyshev, 1974) permits one to estimate a percentage of physical pairs among stellar pairs selected by chance, taking into account brightness, distance between components, and spectral type. In particular, the sample of B stars brighter than 6 mag (outside of any open cluster) contains 70% of physical pairs if $d =$ 21 arcmin. That is just our case.

Then, for our pair (γ Cas and HD 5408) to be a physical pair, it must obey to the following three conditions:

(1) both components have similar proper motions;

(2) both components have similar radial velocities;

(3) the B0IV component must be more luminous than the B9IV star.

Because all these conditions are fulfilled (see Table 1) for our pair it can be considered as a real physical binary system with a probability of nearly 1.

Now we can make some estimates of physical parameters for this binary system. The value of interstellar reddening is evidently very small for this stellar pair. Indeed, $E(B-V)$ is known to be about 0.1 for γ Cas, but this includes the significant part of the intrinsic reddening. If HD 5408 as a B9IV star has $M_V = -0.5$, then the distance to it is 160 pc. This one can assume as the distance to our binary system as a whole. If it is so, then the linear distance between the components in the tangential plane would be 1.0 pc. Taking into account the difference in apparent magnitudes between γ Cas and HD 5408, 3.1V, we found $M_V = -3.6$ for γ Cas. This M_V is not far away from known astrophysical estimates for this star: -4.10 and -4.2 ± 0.2. Because both the components of our pair are known as multiple stars, the total mass of the system would be about 20 solar masses. Supposing nearly circular orbit we can estimate the value of orbital velocity of one component with regard to another: 300 ms^{-1}. The corresponding orbital period for our binary system will be about 20×10^6 years.

Some calculations show that the galactic orbit of γ Cas is nearly circular. Therefore the equations of the Hill's stability problem will be fulfilled almost exactly. A binary system will be stable in the Hill's sense as regards to the regular gravitational field of the Galaxy if its components are inside the surface termed a Hill's sphere. This Hill's sphere is similar to a three-axial ellipsoid sharpened at both ends of the major axis directed towards the Galactic Centre. The equation of a Hill's sphere along with the method of its parameter determination is given in the paper by Antonov and Latyshev, (1971).

The dimensions of the semi-axes were determined as 3.85 pc for the major semi-axis, termed the radius of the Hill's sphere, and 2.58 and 2.01 pc for two others. If components of our binary system are not strictly placed in one tangential plane, then the difference by 1.5 pc in the line-of-sight direction leads in our case to an increase of the linear distance between the components from 1.0 to 1.8 pc. Because 1.8 pc is less than the length of the least semi-axis, one can be sure that both our stars are inside the common Hill's sphere. Therefore, the motion of each component in our binary system is stable in the regular gravitational field of our Galaxy.

References

Antonov, V. A. and Latyshev, I. N. (1971) *Astron. Zh.* **48**, 854.
Cruz-Gonzales, C. and Poveda, A. (1971) *Astrophys. Space Sci.* **13**, 335.
Latyshev, I. N. (1974) *Astron. Zh.* **51**, 786.
Nezhinskij, E. M. (1971) *Bull. Inst. Theor. Astron.* **13**, 31.