THE NEARBY BINARY, STEIN 2051 (G175-34AB)

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ABSTRACT

Photographic observations of the large proper motion binary, Stein 2051, extended over the period 1966-87, do not support that it is a triple system as previously reported (Strand, 1977). The orbital motion is nearly linear over this interval; however, when results of plates from the Vatican Astrographic Zone from 1908-11 are included, a mass ratio is obtained, leading to a mass of 0.50$\odot$ for the white dwarf component, given the calculated mass of 0.24$\odot$ for the red dwarf component.

ASTROMETRIC RESULTS

Stein 2051 (04:31.2, +58°59' (2000)) is listed in the catalog of double stars from the Vatican Zone of the Astrographic Catalog (Stein, 1930). This binary has the largest proper motion discovered in the Lowell survey (Giclas et al., 1965), where it is designated G175-34AB and identified as Stein 2051, a white dwarf/main sequence dwarf binary.

A total of 251 plates was obtained with the U.S. Naval Observatory 61-inch astrometric reflector over the interval 1965-87. Both components on these plates were measured (by V.K.) on the semi-automatic measuring machine, using the same reference frame of seven stars for the epoch 1965.7 described in the previous paper (Strand, 1977). The combined solution gives a relative parallax of 0".178+".001 (m.e.), leading to an absolute parallax of 0".180, given the mean parallax of 0".002 for the reference stars (Vyssotsky and Williams, 1948).

The annual proper motions of the two components are 2".4217±".0001 (m.e.) towards 146°.9 and 2".3614±".0003 (m.e.) towards 144°.8 for the equinox 2000. These motions include the effects of the orbital motions

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of the components, and since these must display equiform curves with the one shown by the relative motions of the two components, they can be derived by successive approximations by varying the proper motion of the system. This was accomplished by the determination of the equiform triangles displayed by an early, a midpoint, and a late epoch normal place (the Vatican 1910, USNO 1966, and the USNO 1985 places, respectively).

Comparing the dimensions of the triangle displayed by the relative motion of the two components with those of each of the two components, we find relative values of 0.674+.004 (m.e.) for A and 0.325+.005 for B yielding a mass ratio $\mathfrak{M}_B/\mathfrak{M}_A$ of 2.07. The proper motion of the system is 2.3832 towards 145°.4, giving a tangential velocity of 60 km/sec, which is quite normal for an old disk population system.

MASSES OF THE COMPONENTS

The average of the Hardie and Heiser(1966) and the Eggen and Greenstein (1967) photometric results yield apparent magnitudes for the components of $m_v(A)=11.09$ and $m_v(B)=12.44$. With the above parallax the absolute magnitudes are $M_v(A)=12.37$ and $M_v(B)=13.62$. That for A is normal for a dM4 star, as classified by Eggen and Greenstein(1967).

Based upon a mass-visual magnitude relation established for late M-dwarf main sequence stars (Strand 1977), the mass of the A component is 0.24⊙. Using the mass ratio herin derived, the white dwarf has a mass of 0.50⊙. Eggen and Greenstein (1967), and Liebert (1976) have classified the spectrum as a CD white dwarf. Spectrophotometric scans and Stromgreen photometry were fit to model atmospheres with hydrogen/metal deficient composition by Liebert, who derived a temperature of 7050±400K, a radius of 0.011±.002R⊙, and a surface gravity of 8.03±.12.

Although the position angle of the relative orbit has changed 70 over the interval 1909-1987, the orbit is still indeterminate and is estimated to remain so for several centuries, because of the linear motion so far observed. The mass of the white dwarf depends, therefore, entirely upon the assumed mass of its red companion, and its uncertainty is therefore twice the uncertainty of that of the companion. estimated at 0.03. However, in view of the paucity of known masses of white dwarfs, Stein 2051B represents an important data-point on this subject. While it is slightly more massive than 40 Eri B (0.43), it is nearly equal in mass to each of the two white-dwarf components of the binary G107-70 (Harrington et al., 1981).

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