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NOTE ON THE MULTIPLICITY OF dMe STARS *

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RESUMEN

Actualmente hay mucho interés en las estrellas ráfaga de tipo dMe con especial preocupación en conocer sus edades y el mecanismo que produce el destello. Unas 50 estrellas Me están en el programa astrométrico del Observatorio Sproul, las que han sido descritas como estrellas ráfagas o potencialmente ráfagas (Lippincott 1971). Por lo menos de la mitad de ellas, se sabe son miembros de sistemas binarios o múltiples. Todas están en el programa de Sproul para encontrar paralajes precisas y para analizar las observaciones a largo plazo para encontrar movimientos propios no lineales que indiquen la presencia de compañeras invisibles. Se discuten los resultados astrométricos y se presenta la estadística de la multiplicidad entre estos sistemas cercanos.

ABSTRACT

There is much current interest in flare stars of the type dMe with particular concern as to their ages and mechanism responsible for flaring. Some fifty Me stars are on the Sproul Astrometric program. They have been discussed as flare stars or potential flare stars (Lippincott 1971). At least half are known to be members of binary or multiple systems. All are on the Sproul program to obtain accurate parallaxes and to analyze the long interval observations for non-linear proper motions indicating unseen companions. The astrometric results are discussed and statistics presented for the multiplicity among these nearby systems.

In recent years there has been much interest in flare stars and the mechanism which produces the flares. Speculation has included duplicity with the flare caused by the proximity of the companion. It is only among the nearby stars that flare stars of late dwarf spectral type can be found due to their intrinsic faintness. I shall consider for the moment that all dMe stars are potential flare stars.

To consider the statistics of multiplicity among flare stars and all emission line M dwarfs is treading on unfirm ground, weak by gross incompleteness and selection effects. The source of information in this note comes from the Gliese 1969 catalogue of stars nearer than 20 parsecs; I have chosen to include in this provisional survey only stars of spectral type later than dMl.

* Figure 1 has been reproduced from the *Astronomical Journal*, 1973, **78**, 935, published by The University of Chicago Press for the American Astronomical Society.

The great limitation of this sample is that we are dealing with the intrinsically faintest stars; the absolute magnitude of a dM2 star is taken to be 10.1 (Blaauw 1963) with a sharp decline in visual luminosity with advancing spectral type. The M_v of van Biesbroeck's star of dM5e amounts to 18.6, which appears to be the extreme. The absolute visual magnitude of Wolf 359 is 16.7, spectral type M8e.

Many surveys end with early M type stars where this one dangerously begins. We note for example that for dK5 stars the m_v at 20 parsecs is as bright as 9 so that there is a far better chance that the sample is more nearly complete than for our case where we start with dM2 at visual magnitude 11 at 20 parsecs.

The only reasonable way to evaluate this group of emission M stars is to compare them with their counterpart of M dwarfs without emission.

The following summary gives the results from the Gliese Catalogue:

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M 1.5 and later Number of	*with emission*	*without emission*	*Total*
Entries	78	188	266
Components	139	264	403
Components of other spectral types	11	31	42
Total of M stars	128	233	361

The final "total of M stars" includes spectroscopic and unseen astrometric components; since these are fainter than the visible component they may be considered as later type dwarfs. The grouping of the components of the two sets of data yields:

	Systems with emission		*without emission*		*Total*
Quadruple	2		1		3
Triple	11	107	12	138	23
Double	33	components	49	components	82
Single	32		126		158

which includes components known as

Spectroscopic	~13	~7
Unseen astrometric	~7	~3

Proper motion companions are also included.

It is not surprising to find the total number of emission M dwarfs to be far fewer than those without emission. This has been noted before but the ratio of single to multiple (including duplicity) appears quite different between the two groups. Also in general the emission M stars are presumably younger than those without emission and their space velocities may be different; however the space velocity of the sample given here for Me stars yields 20 km s^{-1} for the solar velocity (Lippincott 1971). Selection effects due to proper motion are not an obvious cause for the abundance of common proper motion companions which enlarges the Me group. The average apparent visual magnitudes of the two groups are 11.1.

It is possible that more investigators have been interested in spectra of Me stars due to potential flaring and that more spectroscopic binaries have been found among this group than that without emission but again this does not make up for the apparent distribution. Bopp (1974) among others has investigated the spectra of several late Me dwarfs know to flare. For EQ Peg, EV Lac, AD Leo, and V1054 Oph he has concluded that they are likely not spectroscopic binaries which would indicate that the close proximity of a companion star is not a necessary condition for flaring.

Within the sample there are 34 stars that have been known to flare. Only ten are known as spectroscopic binaries or have companions within a radius of 10 AU, leaving 24 flare stars which appear "isolated".

Sixty-eight systems of the emission line group are on the Sproul program. Among the known doubles only one has had an unseen astrometric companion, placing it in the realm of a multiple system of three

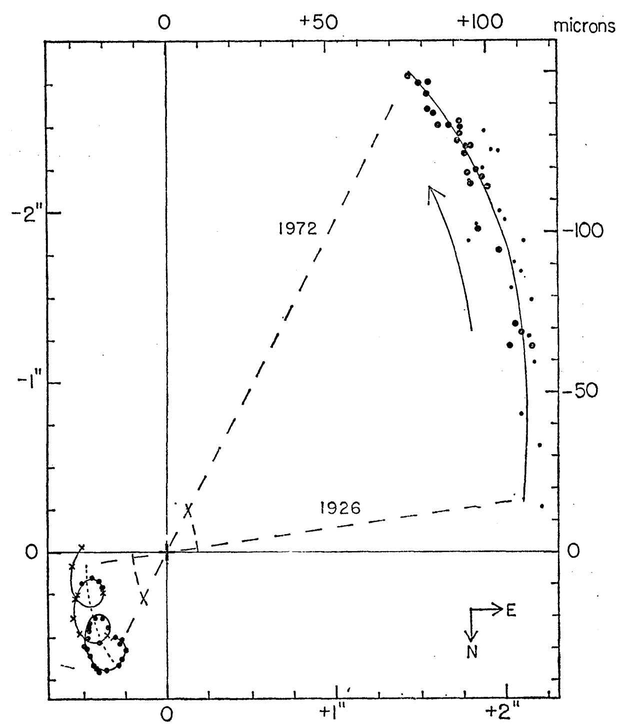

Fig. 1. Positions of BD + 66° 34 Aa and B around their center of mass at the origin. The large points represent photographic positions from the Sproul 61-cm refractor; the small ones are visual observations. The dashed line in the helix is the path of the center of mass of the Aa orbit. The orbit of the unseen companion a has a period of 15.78 years.

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components—namely BD + 66°34. Triplicity was discovered from the perturbation by Alden (1947) from plates taken at the McCormick Observatory. A recent analysis by Hershey (1973) from plates taken at the Sproul Observatory from 1938-1972 indicate that the third body has a mass of 0.13 $\mathcal{M}_{\odot}$ while its two visible components have spectral types dM2.5e and dM4.4. It follows that the unseen companion, some 5 AU from the A component is likely a late M type dwarf. Figure 1 is taken from the study of John Hershey. It should be noted in passing that the M3.5e star Ross 318 some 5° away in the sky has space motion similar to that of BD + 66°34.

Perhaps the weak and unexplained conclusions serve to point out the obvious need for more astrometric, spectroscopic and photometric observations of M dwarfs.

REFERENCES

Alden, H. L. 1947, *A. J.*, **52**, 138.

Blaauw, A. 1963, *Basic Astronomical Data*, ed. K. Aa. Strand (Chicago: University of Chicago Press), 383.

Bopp, B. W. 1973, *A. J.*, **78**, 935.

Hershey, J. H. 1973, *A. J.*, **78**, 935.

Lippincott, S. L. 1971, IAU *Colloquium* No. 15, *New Directions and New Frontiers in Variable Star Research*, Bamberg.

DISCUSSION

Evans: One must use the designation dMe to refer to stars with Balmer emission as well as H and K and not the latter alone. In addition, we know cases where the emission lines have disappeared and the classification dMe would no longer apply.

Abt: If I recall correctly, the only four M dwarfs with known spectroscopic orbits are all dMe stars. I would like to ask Dr. Evans whether he would comment on the possibility that the Me stars are the closely spaced doubles.

Evans: I cannot answer for the statistics out of my head. This is true of many of the stars, but Bopp claims that there are some dMe stars, that is, in our book, flare stars, which are single.

Abt: If we ignore for the moment the differences between absorption and emission stars, but combine the multiplicity data and convert to percentages, these data give quadruple : triple : double : single = 1:9:30:60, while for the FG stars the numbers are 2:9:46:42. I submit that the differences reflect only the more intensive search for spectroscopic doubles among the FG stars.

Fekel: I might comment that one might expect more binaries to be found in dMe's rather than dM's because higher dispersion spectrograms are possible for stars with emission lines.

Carrasco: The 10 brightest known flare stars in the Pleiades only appear as dMe stars at relatively high dispersions, having H and K lines in emission but no Balmer line emission.

King: Can the greater tendency of multiple stars toward emission be a selection effect? Emission is more common in later M stars, and the secondaries tend to have later spectral types than the primaries.

Lippincott: Some investigators believe that all very late type M stars show emission.

Poveda: I find it difficult to relate multiplicity with the emission-and flare-phenomenon, in view of the well known relation betwen age and chromosphic activity. The implication would be that multiplicity is related to the age of the system.

Evans: The effect does not seem to show in the kinematics of flare stars as compared with so-called normal M dwarfs.

Huang: I agree with Dr. Evans that emission may occur in all M stars. Indeed, that has been my own belief because all M stars are convective. But I also believe that the emission phenomenon is sporadic. Some stars show emission more frequently than others. That we see a star has emission lines now indicates that this particular star has a great chance to show frequent emission. Therefore Dr. Lippincott's result has statistical significance.

Worley: You have only listed quadruple systems. However, the system Wolf 629 is in fact a spectroscopic binary as reported by Joy, if in addition the 221 arcsec companion reported by van Biesbroeck is considered.

Lippincott: I did not create a category for five bodies. Also, only one component shows emission; in fact, it has flared, which poses another problem of whether the system should fall in the emission group or that without emission.

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