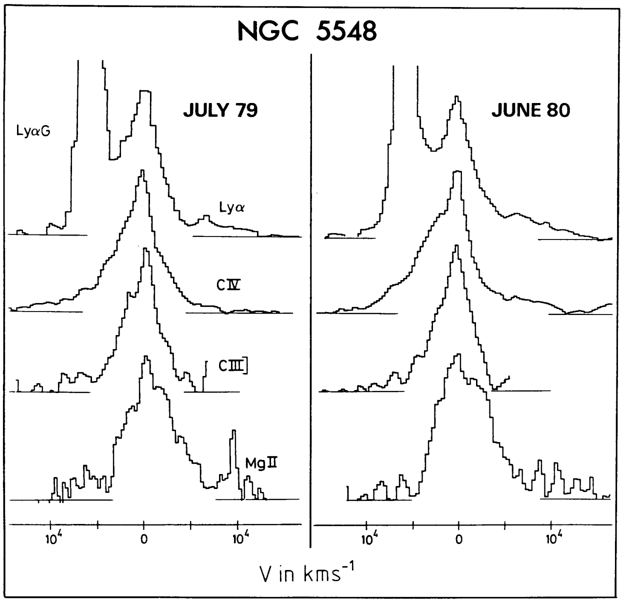

Fig. 3: *The profiles of the main UV lines in NGC 5548, June 1980 and July 1979 scaled in velocity.*

with the intensity of the continuum. The C IV λ 1549 intensities are well correlated with the continuum at 2500 Å, but show a time-lag of ~15 days between the variations of the continuum flux and the lines, this delay being due to light travel time in the C IV region. The C III] λ 1909 intensity remains constant, suggesting an emission region larger than a light year. There is only an insignificant correlation between Mg II λ 2800 and the continuum at 2500 Å (Ulrich *et al.,* 1983, preprint).

In all the objects we have looked at, there is a general trend for emission lines and widths (Fig. 2) to vary in the same sense as the continuum, those from highly ionized species varying more than those from less excited ions, but no tight correlations are found.

A striking point is that, at a given epoch, comparison of the profiles of the most intense broad lines (C IV, Mg II, C III]) with a good signal-to-noise ratio, reveals differences in the width of the lines (Fig. 3). For NGC 3516 and NGC 5548 (Ulrich and Boisson, 1983, *Ap.J.,* in press), as for NGC 4151, we can distinguish at least 3 regions:

(1) emitting the wings of C IV only, with the largest velocity dispersion (~2 10^4 km s^{-1});

(2) emitting Mg II and C IV of FWZI ~ 10,000 km s^{-1}, C III] not being detected;

(3) emitting the 3 lines of FWZI ~ 4000 km s^{-1}.

For the others, the subdivision in (2) and (3) is less clear. One should also note that sometimes, when the continuum is faint, all the lines are "narrow". It seems that, the emitting region being small, one is witnessing the lightening or the extinction of shells located at different distances from the centre.

From this point of view, Seyfert galaxies appear different from quasars. This difference could be an absolute luminosity effect and observations of faint quasars are needed to test this hypothesis.

Conclusion

In the 7 Seyferts analysed, as in NGC 4151, (i) the continuum becomes harder when it brightens; (ii) there is a general trend for emission lines and widths to vary in the same sense as the continuum, (iii) matter appears not to be distributed in the broad line region (BLR) of Seyferts as it is in quasars: for Seyferts we can distinguish regions where the gas has different physical conditions and velocities.

The Variability of RR Tel

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Introduction

In the course of its history, RR Tel has been described as a member of different stellar classes. In fact, it is a galactic nova for which only one outburst has been recorded and whose lightcurve before that outburst is one of the best known.

Spectroscopically, the star has also been extensively observed in the various wavelength ranges. Present infrared variations are well established and interpretations of the nature of RR Tel point to a symbiotic object containing a Mira variable and a dust component. A blue component is also believed to be present. We will show how simple photometric observations carried out at ESO, together with other sources of data, bring an interesting complement to this model.

First Observations

RR Tel was discovered as a variable by W.P. Fleming (*Harvard Circ.* **143,** 1908) from 19 Harvard plates spread over 13 years. At this time, she suggested the star (then named HV 3181) might be of the SS Cyg type, also called U Gem type.

In 1945, S. Gaposchkin derived a period of 386.73 days from 40 acceptable observations (*Harvard Ann.* **115,** 22) and this period of about 387 days was adopted by Kukarkin and Parenago in their 1947 catalogue where they presented the star as a semi-regular variable.

The outburst had occurred in November 1944, but it remained unnoticed until the South African amateur astronomers P. Kirchhoff and R.P. de Kock discovered in 1948 that the star had increased from fainter than twelfth to about the sixth magnitude.

The pre-outburst behaviour of the star can be appreciated in Fig. 1 reproduced from the work of M.W. Mayall (*Harvard Bull.* **919,** 1949, 15) who examined all Harvard plates available when the star brightening was discovered. This led to more than 600 positive observations of the star between 1889 and 1947 which pointed out the occurrence of the outburst at the end of 1944, as well as the stronger variations which preceded it.

Actually there is little evidence of periodicity in the variations from 1889 to 1930, where the observed amplitude was about 1.5 magnitude with a maximum varying between 12.5 and 14. Later, however, the periodicity became evident and the amplitude increased up to three magnitudes approximately.

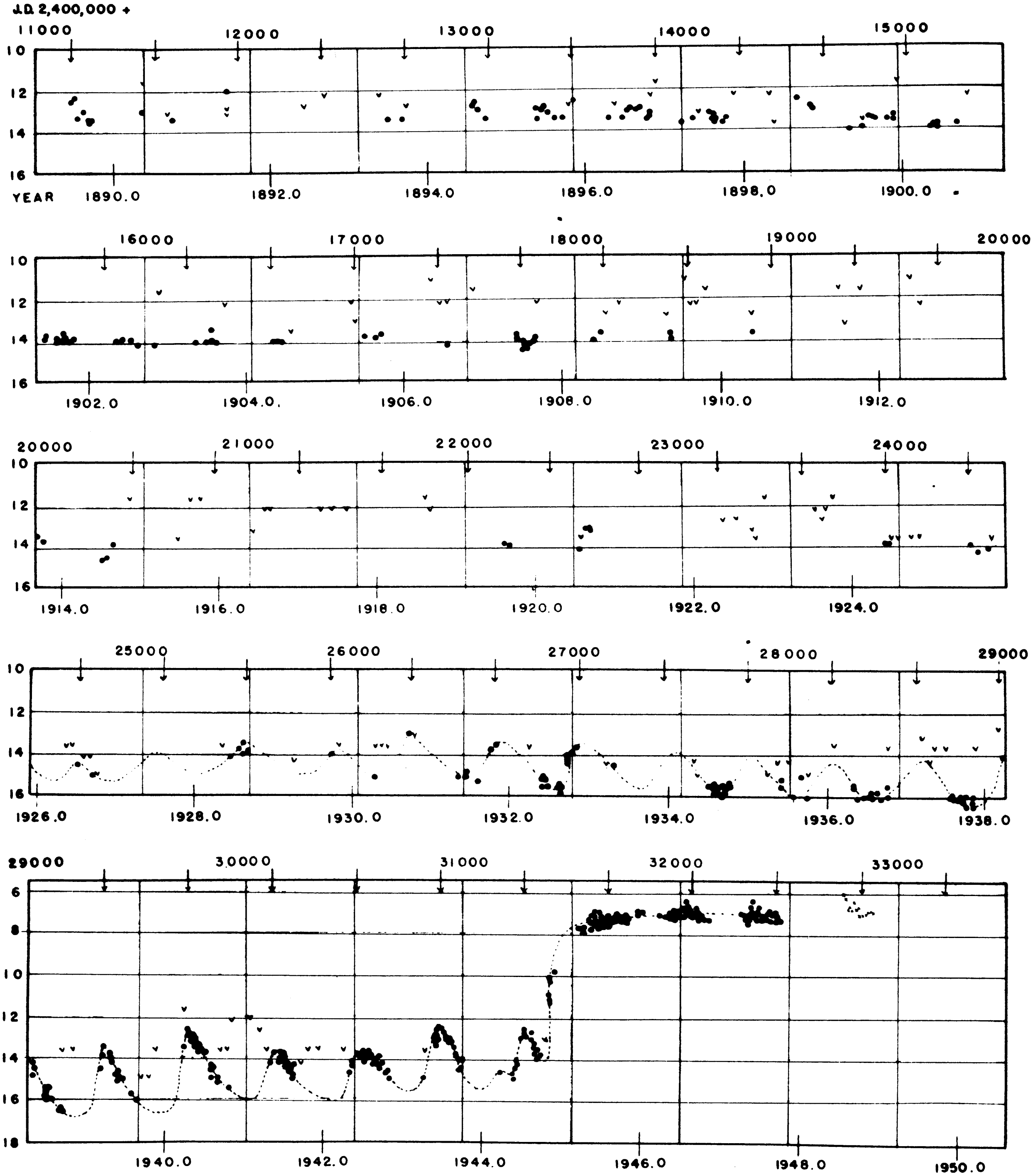

Fig. 1: *The variations of RR Tel from 1889 through 1947, reproduced from the work of M. W. Mayall (1949,* Harvard Bull. **919,** *15).*

The outburst brought the star close to magnitude 6 where it remained from 1944 to 1949. RR Tel started to fade in June 1949.

Infrared Connection

The star had obviously become an interesting object. In the fifties started a phase of intense spectroscopic investigations in the visible, in the infrared and recently even in the ultraviolet range with the IUE satellite.

In the UV (refer to the paper by Heck et al. in the December 1978 issue of this journal – No. 15, p. 27 – or to the detailed description by Penston et al. to appear soon in the *MNRAS*), the spectra display thousands of emission lines, making RR Tel an extremely interesting object for atomic physics.

Obviously, we will not review here in detail the studies carried out during 30 years in the other spectral ranges. An excellent synthesis of the successive evolutionary stages of RR Tel has been published by A. P. Thackeray in 1977 (*Mem. Roy. Astron. Soc.* **83,** 1). The visible spectrum was characterized by nebular lines of different ionization stages of intensity increasing with time.

The first suggestion that RR Tel was a symbiotic object came from K.G. Henize and D.B. McLaughlin in 1951 (*Astrophys. J.* **114,** 163) who believed the star was composed of a long-period variable (presumably of class M) and of a typical RT Ser slow nova, although they retained the single-variable hypothesis as possible because of the increase of the amplitude before the outburst.

Later, M.W. Feast and I.S. Glass (*MNRAS,* **167,** 1974, 81) concurred in the presence of cool M5III star (reinforced by the discovery of TiO bands in the spectrum by B.L. Webster) and of an infrared dust shell to explain the energy distribution of RR Tel. They also attributed the pre-outburst periodic variations to a semiregular pulsation of the cool component.

In 1977, M.W. Feast and his collaborators reported large JHKL photometric variations of the stellar component (*MNRAS* **179,** 499) which could be attributed only to a Mira-type variable in their opinion. The presence of a Mira near minimum light was then confirmed by D.A. Allen et al. (*MNRAS* **182,** 1978, 57P) from a detection of intense steam (H_2O) and weak CO absorption bands which are characteristic of many Mira variables. They also deduced, from period-spectral type relations for Miras that the present cool component does not differ radically from the pre-outburst variable.

Quite recently (paper in press in the *MNRAS*), M.W. Feast and his collaborators derived a periodicity of 387 days in the JHKL photometric data collected during the epoch 1975–1981 (see Fig. 2), that is a period very close to that obtained by S. Gaposchkin from photographic pre-outburst records. They also found the present J index compatible with a Mira photographic magnitude of 13–14 in the pre-outburst phase, which would mean that the Mira has been present at all times with a constant period and a constant mean luminosity, the variation going from $\sim 13^m$ to $\sim 17^m$ or fainter. There would be another component of radiation whose intensity varies on a different scale and which would be presumably responsible for the outburst.

Post-outburst Variability in the Visible Range

To the best of our knowledge, and curiously enough, no extensive study has been made on the variability in the visible range, for the post-outburst phase. On the contrary, brief mentions in the literature point towards no evidence of variability in that range or at least towards no evidence since the outburst of this 387-day period found in the infrared.

During the simultaneous spectrophotometric joint ground and space observations carried out in June 1978 (see the papers by Heck et al. and Penston et al. mentioned earlier), variations of the order of $0\overset{m}{.}034$ r.m.s. have been suspected from night to night and within a night from uvby data collected at

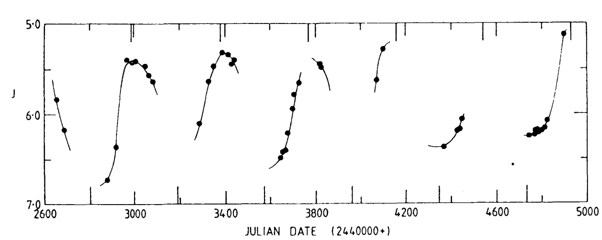

Fig. 2: *Variations of the J index for the years 1975 to 1981 (according to the paper by Feast, Whitelock, Catchpole, Roberts & Carter to be published in* MNRAS*).*

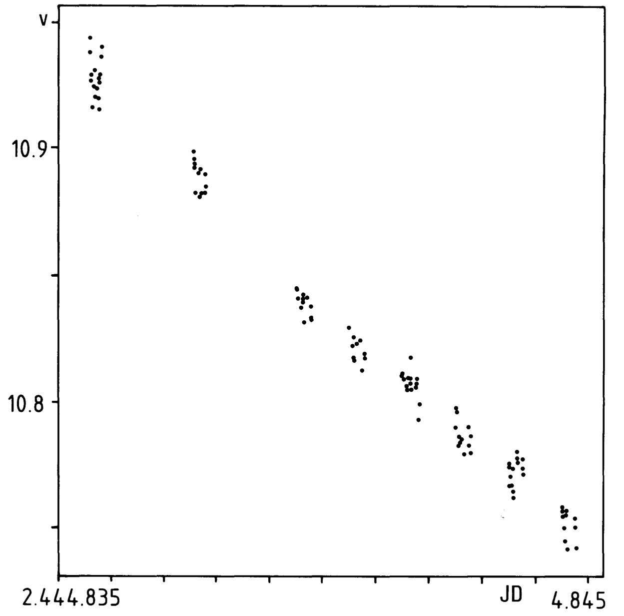

Fig. 3: *Variations of the V magnitude from observations in the uvby system at the 1 m ESO telescope in August 1981.*

the 50 cm ESO telescope and from the Geneva $UVB_1B_2V_1G$ data collected at the Swiss 40 cm telescope on La Silla. The fluctuations were larger than what would be expected from the intercomparison of the reference stars and from the fit to the standards. The paucity of points prevented any detailed study of these variations.

The Star was re-observed in bad conditions (low on the west horizon at sunset) in December 1978 with the 50 cm ESO telescope. Very careful reductions of the data did not show significant variations.

It was then interesting to attempt to clear up these conflicting results and to establish the form of the possible variations with a more powerful instrument. A first tentative took place in August/September 1980, but could not be carried out properly because of what an observer has to face sometimes: bad weather and instrumental failures. The few data collected seemed however to indicate a slight faintening of the V magnitude.

Another attempt, quite successful this time, was carried out in August 1981 with the 1 m ESO telescope equipped with a standard one-channel photometer working in the uvby system. The results are summarized in Fig. 3, displaying a clear brightening of RR Tel during the period of observations.

These results have to be directly compared with Fig. 2. In August 1981, the brightening in V corresponds clearly to the brightening in J, but the tendencies would be opposite in September 1980 if the trend detected in V is real. In 1978, the V magnitude had no clear behaviour, while the J one was varying steeply at the time of the visible observations. In conclusion, there is apparently no evident correlation between the V and J variations, except in 1981.

Also RR Tel has been repeatedly observed by the IUE satellite, and Fig. 4 reproduces the B magnitudes deduced from the counts recorded at the time of the observations by the IUE Fine Error Sensor (FES). A Fourier analysis performed on these data gave a period equal to 395 (± 5) days. If a Fourier analysis is applied to the J values listed by M.W. Feast and his collaborators for the epoch 1972–1981, a period of 390 days is found, which is very close to the previous one. Also the location

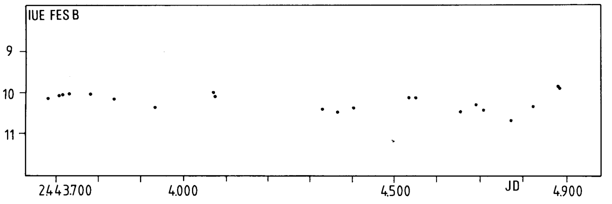

Fig. 4: *IUE FES B magnitudes from 1978 to 1981.*

of the maxima in time on the J and IUE FES B lightcurves agree very well.

Another interesting curve can be obtained from the records of the American Association of Variable Stars Observers. Fig. 5 displays the available visual estimates averaged by groups of 50 days for the years 1949 to 1963. Further monthly averages were also available to us for the epoch 1972–1977. Apart from a general decline after the outburst, a periodicity is also clearly visible.

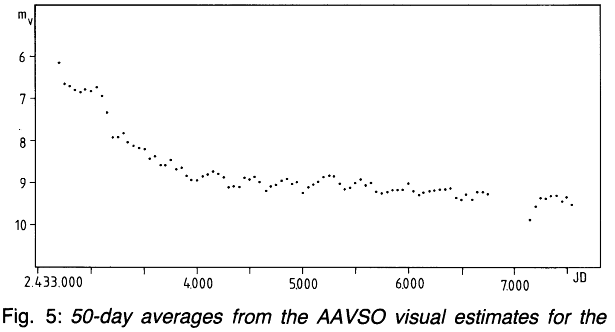

Fig. 5: *50-day averages from the AAVSO visual estimates for the years 1949–1963.*

Although visual estimates are less precise than photoelectric measurements, Fourier analyses of these data can provide quite reliable determinations of the period because of the large number of cycles covered by the time basis available. For the whole 1949–1963 range, a mean period of 355 days has been derived, but a more detailed analysis shows that this period decreased from about 377 days just after the outburst to about 345 days at JD 2,437,000 (1960). It is really a pity that no infrared data were available at that time to check whether this shorter period was also appearing in that range. From the visual averages between 1972 and 1977, it was impossible to determine clearly a period.

Conclusions and Comments

When they are overlapping, the observations of RR Tel in J and IUE FES B magnitudes are coherent, leading to a period of the order of 390 days, that is very close to the value of 387 days proposed by S. Gaposchkin in 1945 from forty pre-outburst observations. The V values for 1981 are also in agreement and those for 1978 and 1980 are too uncertain to be declared in definite disagreement. There are also strong suspicions on the occasional presence of short-time scale variations in V.

Moreover, it is certain that the period in the visible range did not remain constant from the pre-outburst phase until nowadays. It has been shorter immediately after the outburst and has been decreasing at least until 1960. No data are unfortunately available in the infrared range during this period. So the hypothesis by Feast et al. that a Mira has been present at all times with a constant period cannot be checked then. Nevertheless, the spectral evidence of H_2O and TiO bands supports the Mira presence, as well as the very pre-outburst behaviour.

The visible variations from the outburst until nowadays, however, cannot be accounted for directly by the Mira if this component remained constantly between 13^m and 17^m. It is easy to show that such variations would be completely masked by another component of radiation as soon as this would be brighter than about 11^m.

The variations of this blue component contributing to the visible light might have been related to the rate of mass loss. The interesting point is that it seems now to have returned to the Mira periodicity after a long time of different behaviour. This could indicate the end of a crisis.

A.R. Walker (1977, *MNRAS* **179,** 587) proposed that the outburst had been triggered by an increased mass accretion from the implied Mira because of the necessary rate of mass loss. A more sophisticated model has recently been proposed by G.T. Bath (*MNRAS* **182,** 1982, 35): RR Tel would be a case in which modulated bursts of mass transfer and associated accretion events were occurring within the underlying binary star prior to the major eruption in 1944. The outburst itself would have been caused by a sudden onset at a super-critical rate. In that picture, RR Tel could be the missing link between dwarf novae, classical novae and symbiotic stars.

The Diffuse Interstellar Medium and the CES

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Introduction

Representing a few per cent of the mass of our Galaxy, but 30–40 % in the case of the Small Magellanic Cloud, it is well recognized that diffuse matter in space plays a decisive role in the evolution of galaxies. Primordial gas—together with material ejected in stellar winds, novae, supernovae, planetary nebulae and other types of evolved stars, and enriched in heavy elements through nucleosynthesis—has accumulated to form a complex and violent medium with an amazing variety of physical conditions, containing regions with densities ranging from 10^{-4} to 10^6 particles cm^{-3} and with temperatures from 10 to 10^6K. From time to time, part of this interstellar medium collapses to form further generations of stars. This simple picture of evolution is altered by possible accretion of intergalactic gas and by matter circulation between different parts of a given galaxy, including a gaseous halo; activity in the galactic nucleus may also play a role.

With the exception of the H II regions surrounding the massive, young stars, the planetary nebulae and the centers of dense molecular clouds, the interstellar atoms, ions and molecules are in their ground states (because densities and the