A-type central stars of planetary nebulae — I.  
A radial-velocity study of the central stars of NGC 2346 and NGC 3132

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Summary. Radial-velocity measurements of the A-type central stars of NGC 2346 and NGC 3132 are presented. The first one is almost certainly a spectroscopic binary; no definite statement can be made about the second.

1 Introduction
The A-type central stars of NGC 2346 and NGC 3132 do not seem to be able to excite their respective nebulae; if star and nebula are physically associated, there must be an additional source of ionizing radiation. The same is true for the two other known A-type central stars, namely those of NGC 1514 (Kohoutek 1968; Greenstein 1972) and He 2-36 (279–301) (Méndez 1977, in preparation), and for several other late-type stars associated with planetary nebulae (see, e.g. Jones, Evans & Catchpole 1969; Lutz 1977).

The binary model, although not the only conceivable explanation, is certainly the most attractive one — at least in the case of the A-type objects — particularly now that several spectroscopic binaries (including NGC 1514) — and also one eclipsing binary — are known among the central stars (Acker 1976; Méndez & Niemela 1977; Miller 1976).

This paper presents the results of a search for radial-velocity variations of the central stars of NGC 2346 and NGC 3132. Earlier work on the central star of NGC 3132 is reviewed by Méndez (1975), who could present only inconclusive evidence of radial-velocity variations. We have not found any similar study on the central star of NGC 2346.

After the present paper was essentially completed, two new results have appeared. Kohoutek & Laustsen (1977) have found a faint blue visual companion of HD 87892, the central star of NGC 3132. On the other hand, the interstellar extinction of the central star of NGC 2346 has been found to be significantly less than that of the nebula (Méndez 1978, in preparation). This fact would imply that the star is a foreground object. These results will be discussed in a separate paper.

2 Observational material
The spectrograms used in this work were obtained on 1976 February 16 to 27 (NGC 3132), and 1976 December 24 to 1977 January 4 (NGC 2346), with the Cassegrain spectrographs of
the 90 and 150-cm telescopes, and the image-tube spectrograph of the 1-m telescope, at the Cerro Tololo Inter-American Observatory. The corresponding plates are labelled A, C and E, and have dispersions of 60, 40 and 45 Å/mm, respectively. The emulsion used at the conventional spectrographs was IIa-O baked in N₂; the image-tube spectrograms were taken on IIIa-J baked in N₂. All the plates were measured by one of us (RHM) with the Grant comparator-microphotometer at La Plata Observatory. The measurements were reduced with the IBM/360 computer of La Plata University.

3 The radial velocities

The spectral types are A5 for the central star of NGC 2346 \( (m_V = 11) \) and A2 for HD 87892 \( (m_V = 10) \). A more detailed description of the spectra will be published separately (Méndez 1978, in preparation). An accurate determination of radial velocities is difficult because of the lack of suitable absorption lines at the rather low dispersion demanded by the faintness of these stars. The presence of nebular emission lines superimposed upon the stellar spectrum complicates the problem. Since we are primarily interested in the eventual variations of the velocity, we have decided to consider only the difference between the stellar and the nebular velocity. Some comments are necessary:

(a) Our basic assumption that the nebular velocity is constant seems quite reasonable. Possible velocity differences between different parts of the nebula are avoided, since we determine the nebular velocity from the emission lines that appear upon the stellar spectrum on equally widened spectrograms. In this way we ensure that we are always measuring the same part of the nebula, and also avoid problems related to erratic behaviour of the spectrographs.

(b) We have restricted our analysis to the radial velocities given by two stellar lines \( \text{Ca}^{+} \text{II} \lambda 4481 \) and two nebular lines \( [\text{Ne}^{+} \text{III}] \lambda 3868, \text{H}_\gamma \). Other features visible on the spectra are of much lower quality. In particular, the Balmer absorption lines are very broad and difficult to measure, their central parts being filled with the nebular emissions. On the other hand, we do not expect the stellar \( \text{H}_\gamma \) absorption significantly to affect the sharp emission peak of the nebular \( \text{H}_\gamma \).

(c) For the plates taken with the image-tube spectrograph, the grating angle has been chosen carefully to minimize the distortion on the selected part of the spectrum (from 3800 to 4500 Å). However, the varying curvature of the slit image along the spectrum might still introduce small systematic differences in the radial velocities of different lines. Therefore, we have decided to consider separately the two differences \( \text{Ca}^{+} \text{II} \lambda 4481 - [\text{Ne}^{+} \text{III}] \lambda 3868 \) and \( \text{Mg}^{++} \lambda 4481 - \text{H}_\gamma \). For consistency, the results of all plates are presented in the same way.

4 Discussion

Figs 1 and 2 show the radial-velocity differences (star—nebula) as a function of time, for NGC 2346 (1976 December—1977 January) and NGC 3132 (1976 February), respectively. The difference between the two nebular lines is plotted in the lower part of each figure for comparison. No systematic effects depending on the spectrographs are evident.

We note that the difference involving \( \text{Ca}^{+} \text{II} \) gives systematically more negative values than the other one. This is not an instrumental effect, because it happens on all plates, irrespective of the spectrograph used; probably it is due to line blending. This discrepancy is of the order of 5—10 km/s for both stars, and is not very important since we are more interested in the separate behaviour of both velocity differences.

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Figure 1. Radial-velocity differences (star–nebula) in NGC 2346: crosses: (Ca II K) − ([Ne III] λ 3868), circles: (Mg II λ 4481) − (Hγ). The lower part shows the difference ([Ne III] λ 3868) − (Hγ): triangles: plates 'A', squares: plates 'E'. The letter C indicates plate C4736c.

Figure 2. Radial-velocity differences in NGC 3132. The symbols are the same as in Fig. 1.

Because of the method used, we need an estimation of the internal errors only. A conservative estimate is that the uncertainty in a single velocity-difference measurement is of the order of ±10 km/s. This is somewhat larger (but also more realistic) than the values currently found in the literature for dispersions of 40–60 Å/mm.
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The available data suggest that the radial velocity of the central star of NGC 2346 is variable, with a total range of about 30 km/s and a period apparently not much longer than 10 day.

In the case of HD 87892 the situation is not so clear. Fig. 2 would suggest variations with a period of 5–6 day, but with a total range of at most 20 km/s, which is consistent with previous observations (Méndez 1975) but not large enough to consider the variations as definitely confirmed.

Further determinations of radial velocities for these stars should be attempted at higher dispersions and with a better time distribution to define the radial-velocity curves more precisely.

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References


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