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V 605 Aquilae – a Star and a Nebula with No Hydrogen

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Three planetary nebulae are known with hydrogen-poor central nebulosities and WR-type central stars: A 30, A 78 and A 58. While the former have been discussed extensively in the literature, the latter remained spectroscopically unknown until 1983. Its story, however, begins much earlier.

In 1920 Max Wolf found a $10^{m}.4$ star on photographic plates taken in 1919. The object had been invisible before 1917; it disappeared in 1923. In 1921, Lundmark took spectra of the suspected nova. These had no resemblance with spectra of any of the known evolutionary states of novae, they looked like those of carbon stars. Decades later, the region around the star, now designated V 605 Aql, was inspected. Abell (1966) found a faint old planetary nebula and entered it as number 58 into his catalogue, Herbig (1971) noticed a very faint starlike object near the centre of A 58 and suggested that this was the remnant star of V 605 Aql.

Our own story of V 605 Aql and A 58 starts in 1983, when I joined H. Duerbeck in his spectral survey of faint old novae with the Calar Alto 2.2-m telescope. The central star of A 58 was not visible on the telescope monitor. However, we had just recorded another unseen old nova, V Per, because it had appeared somewhere along the long slit with which the unwidened spectrum was taken. Thus, the long slit was placed across the planetary nebula in various positions. When it lay exactly across the centre, as deduced from the pattern of spectra from neighbouring stars, a central point-like emission spectrum appeared in addition to the emission lines of the extended planetary nebula. The central nebulosity showed no hydrogen, only strong [O III] and moderately strong [N II] lines, slightly blueshifted with respect to the planetary emission lines (Seitter 1985a).

An EFOSC spectrum taken for us with the ESO 3.6-m telescope by P. Angebault in 1986 shows the spectra of *three* objects: lines of the planetary nebula and the central nebula and stellar emission lines superimposed on a weak continuum of red magnitude 22.3 (Seitter 1987).

Follow-up observations were obtained on July 1/2, 1987, again with the EFOSC at the ESO 3.6-m telescope. A slit width of 1″ was chosen in order to clearly separate the [N II] 658.4, 654.8 nm lines at a dispersion of 23 nm/mm. The mean spectra obtained in the blue and red/near infrared regions are shown in Figures 1 to 4. In all spectra, contributions from the night sky and the planetary nebula are removed. The subtraction of the latter rests on the assumption that the strengths of the nebular lines towards the northern part of the PN do not differ from those superimposed on the central nebula. This seems to be justified from the appearance of the hydrogen lines in the two-dimensional spectra, where no differences are noticed between the two regions (see Figs. 2 and 3 in Seitter 1985b).

The result is striking as seen in Figure 4: no trace of Hα is found between the nitrogen lines. The central nebula of A 58, which also appears to be the remnant nebula of the nova-like outburst of the central star V 605 Aql in 1917, is the foremost candidate for a nebula entirely free of hydrogen.

The central star of the two nebulae exhibits a strong C IV 580.6 blend, besides marginal lines of He II 468.6, O V and O VI. The broad C IV feature with a FWHM of 2,300 km/s and a total width of 4,400 km/s suggests that this star is of WR type, as are the central stars in A 30 and A 78. An additional similarity of the three objects is the presence of cool dust. Extended dust shells of 140 K were derived for both A 30 and A 78 (Cohen and Barlow 1974) while the IRAS data indicate a point source of 170 K for A 58.

The central object of A 58 is interesting not only because of its extreme properties but also because the outburst was observed photometrically and spectroscopically. This puts severe constraints on any theory trying to explain the observed phenomena.

Following earlier suggestions (e.g. Iben et al. 1981 for A 30 and A 78, and Pottasch 1985 for A 58) the central stars of all three PNs are candidates for post helium shell flash evolution. The central nebulae in A 30 and A 78 have kinematic ages of a few thousand years. If the central stars reached their observed positions in the H-R diagram during the same time interval, one finds fair agreement with evolutionary computations. V 605 Aql, on the other hand, has reached a magnitude comparable to its pre-outburst brightness after less than 70 years.

Because the temperature determination is difficult for a star which displays just one well-defined line, the bolometric