Fading and Variations in the Spectrum of the Central Star of the Young Planetary Nebula SAO 244567 (Hen1357)

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SAO 244567 (= Hen 1357) is a very young planetary nebula. It was discovered by Parthasarathy et al. (1993, A and A 267, L19). Based on the spectrum obtained around 1950 Henize (1976, ApJ Suppl 30, 491) classified it as a B or A type H-alpha emission line star. The optical spectrum of SAO 244567 obtained in 1971 shows that it was a post-AGB B1 supergiant at that time. It has turned into a planetary nebula within the last 20 years (Parthasarathy et al. 1995, A and A 300, L25).

Recently Bobrowsky (1994, ApJ 426, L47) obtained narrowband optically resolved images of SAO 244567 with the HST Planetary Camera. The HST images in both H-beta and [OIII] 5007 A show a well resolved nebula surrounding the central star.

The IUE ultraviolet spectra obtained during the last eight years (1988 to the most recent one in August 1996) show that the central star is rapidly evolving. It is found that the central star of this young PN has faded by a factor of 3 within the last eight years. The terminal velocity of the stellar wind has decreased from -3500 km/sec in 1988 to almost zero in 1994. In 1988 the C IV (1550A) line which was a P-Cygni profile with strong absorption component has almost vanished by 1994. The CIII] 1909A emission strength has increased very markedly within 4 years (1988 to 1992) (Parthasarathy et al. 1993, A and A 267, L19). The UV nebular features show variations in strength. This may be due to the fading of the central star and also possibly to expansion of the nebula.

These results suggest that in the central star the nuclear fuel is almost extinct as a result of post-AGB mass loss. The main stellar energy may be gravothermal energy. Typical for hydrogen-burning AGB remnants is a very fast drop in luminosity by an order of magnitude when burning cannot be sustained any longer. These results suggest that the central star of this young PN is rapidly evolving to become a DA white dwarf.

An alternative interpretation is that the present fading could be due to an episode of high mass loss, which is now just completed. If the ultraviolet fading was a factor of 2.83 from 1988 to 1995, the luminosity would remain the same if the temperature increased from 37500 K to 47500 K in the same period. It may be that these changes occur in steps which are triggered by episodic mass loss periods during the post-AGB evolution.

Assuming a distance of 5.6 kpc the radius of the nebula is found to be 0.02 pc. The expansion age is found to be 2700 years. The luminosity and core mass of the central star are found to be 3000 Lo and 0.55 Mo. The B type supergiant spectrum in 1971 suggests the effective temperature of the this star in 1971 was around 20000 K . The 1995 IUE high resolution spectrum, and the nebular emission line spectrum indicate the effective temperaure of this star now to be around 50000K. The time scale of evolution appears to be very

rapid. For such a fast evolution a core mass of about 0.8 Mo or even higher is required. However the observed luminosity of the central star does not suggest a high core mass. May be the distance estimate to SAO 244567 is uncertain.

The IUE high resolution spectrum obtained by Feibelman (1995, ApJ 443, 245) in 1994 and by us in 1995 shows that the stellar wind has vanished. The OIII] 1660A and CIII] 1909A lines show slight variation in strength. The electron density from the CIII] 1909A line ratio is found to be log Ne = 4.1 cm $^{-}$3. The presence of Fe V and Fe VI lines in the IUE ultraviolet spectrum of SAO 244567 suggests an effective temperature of the order of 50000K.

The B1 supergiant like spectrum of SAO 244567 in 1971 shows that the post-AGB stars before they turn into PN have extended atmospheres and may mimic the spectra of supergiants. It also confirms the evolutionary sequence of post-AGB supergiants from cooler to hotter types and then into young PN.