RevMexAA (Serie de Conferencias), **15**, 78–78 (2003)

A DYNAMICAL MODEL FOR PNE WITH WR-TYPE CENTRAL STARS

S. Medina,[1] G. García-Segura,[2] and M. Peña[1]

In this work we present the preliminary results of a dynamical analysis on a homogeneously observed sample consisting of 21 planetary nebulae with central stars of the [WC] type (WRPNe) from the list of Tylenda, Acker, & Stendholm (1993).

High resolution spectra for all the objects in the sample were obtained to derive the expansion velocity of the gaseous component for each sample object. All spectra were systematically gathered with the 2.1 m telescope at the Observatorio Astronómico Nacional at San Pedro Mártir, B. C., México on 1995 July 29–31, 1996 June 14–17, 1997 August 3–4, 1998 December 11–14, 1999 October 4–7 and 2000 November 1–3, and were always obtained using the REOSC Echelle Spectrograph plus the University College London Camera, whose characteristics have been reported by Levine & Chakrabarty (1993). The description of the observations was given in Peña, Stasińska, & Medina (2001), where a detailed list of objects, observing dates, exposure times and instrumental set-up was given.

We are taking the half width of the line profile at one tenth of the maximum intensity (HW$\frac{1}{10}$I) in km s^{-1} as the highest expansion velocity (convolved with turbulence), V_{10}. The validity of this treatment is thoroughly explained in Medina et al. (2003). In order to investigate how the stellar Wolf-Rayet (WR) wind affects the evolution and/or structure of the nebulae, we applied the analytical solutions for the dynamics of hot bubbles expanding into media with power-law distributions derived by García-Segura & Mac Low (1995, hereafter GSM95) to the gaseous components of our sample objects.

Using the standard evolutionary tracks for planetary nebulae, we were able to translate the observational diagrams (V_{10} and $L_{\rm w}$ vs. T_*) to diagrams involving the evolutionary time (V_{10} and $L_{\rm w}$ vs. t). The stellar parameters (T_*, $\dot{M}$ and v_∞) were taken from the literature.

The mechanical luminosity of the fast WR wind, defined as $L_{\rm w} = 0.5\dot{M}{v_\infty}^2$, where $\dot{M}$ is the mass-loss rate of the [WC] star and v_∞ is the terminal wind velocity, can be modeled as the time-dependent function $L_{\rm w} = \mathcal{L}_0 t^\delta$.

From the analytical solutions derived by GSM95, the expansion velocity of the thin gaseous shell can be written as:

$$\dot{R} = \left(\frac{\delta+3}{3}\right) A t^{\delta/3}, \qquad (1)$$

in which

$$A = \left\{ \left(\frac{\gamma-1}{4\pi\rho_0 r_0^2}\right) \left(\frac{1}{2\delta^2+3\delta+9}\right) \left[\frac{\mathcal{L}_0}{\delta+1+(\gamma-1)(\delta+3)}\right] \right\}^{1/3}, \qquad (2)$$

where γ is the adiabatic index of the hot, shocked gas, and t is the time measured from the beginning of the WR phase.

The solutions given by GSM95 with $\gamma = 5/3$ show that a luminosity increasing in time ($\delta \geq 0$) gives an accelerating, unstable scenario.

So far, from the solutions given by GSM95, we have found that our sample WRPNe objects might have accelerating, unstable shells, since, assuming a mass-loss rate of $\dot{M}_{\rm AGB} \sim 10^{-5}\, M_\odot\,{\rm yr}^{-1}$ and a terminal velocity of $v_{\rm AGB} \sim 10\,{\rm km\,s}^{-1}$, our observational data fit well for parameter values $\delta = 4$ and $\log \mathcal{L}_0 = -10.05$.

[1]Instituto de Astronomía, Universidad Nacional Autónoma de México, Apartado Postal 70-264, 04510 México, D. F., México (selene,miriam@astroscu.unam.mx).

[2]Instituto de Astronomía, Universidad Nacional Autónoma de México, Apartado Postal 877, 22800 Ensenada, B. C., México (ggs@astrosen.unam.mx).

REFERENCES

García-Segura, G., & Mac Low, M.-M. 1995, ApJ, 455, 160 (GSM95)

Levine, S., & Chakrabarty, D. 1994, Technical Report MU-94-04, Instituto de Astronomía, UNAM

Medina, S., et al. 2003, submitted

Peña, M., Stasińska, G., & Medina, S. 2001, A&A, 367, 983

Tylenda, R., Acker, A., & Stenholm, B. 1993, A&AS, 102, 595