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On the chemical composition of the metal-poor planetary nebula PNG135.9+55.9

Christer Sandin

Astrophysikalisches Institut Potsdam, An der Sternwarte 16, Potsdam, D-14482, Germany

R. Jacob, D. Schoenberner, M. Steffen, M.M. Roth

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Christer Sandin, Ralf Jacob, Detlef Schönberner, Matthias Steffen, Martin Matthias Roth

Astrophysikalisches Institut Potsdam, Germany

AIP

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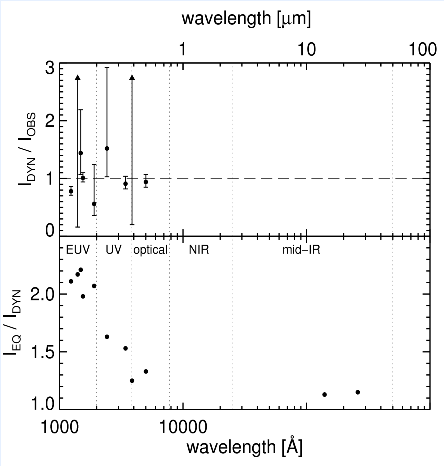
In deriving new abundance estimates our final model meets four criteria

Our RHD models depend on the chemistry, the luminosity, and the temperature of the CSPN, along with properties of the previous AGB wind and the current wind of the hot CSPN. After a set of model iterations we selected a final model that provided the best simultaneous agreement with the observed line intensities (see the upper panel in the right-hand side figure). Additionally, the emission line profile and the surface-brightness structure that were observed by Richer et al. (2003, 2002), both compare well to our model. The apparent size and the Hβ-flux match at a distance of d≈18 kpc.

The element abundances of our final model are on average ~1/13 of the mean galactic disk PNe values (Z_{GD}) – although the oxygen abundance is much lower; about Z_{GD} /80.

In comparison a thermally relaxed model (EQ) is unable to explain all observed line strengths simultaneously; due to a different sensitivity of the lines used to calculate the electron temperature of these models (see lower panel in the right-hand side figure). This finding might explain the current controversy in the literature on the actual metal content of PN G135.9+55.9.



Time-dependent effects are present regardless of other aspects of the modeling, such as the adopted geometry!

Comparison with the approach and outcome of another recent study

Another recent study of PN G135.9+55.9 finds abundances that are very similar to our. These authors use a different approach where they focus on the binary nature of the star. Here we list similarities and differences between our approaches. Note that these two studies are the first to point out the importance to consider the full wavelength range.

Sandin et al. 2010, A&A, 512, A18

Use NEBEL – one-dimensional, fully time-dependent, self-consistently accounts for **expansion cooling.**

Consider the nebula, the CSPN star is excluded.

Model **one** ionizing star with the following parameters: $M = 0.595\ M_\odot$, $T_{eff} = 138$ kK, $L = 3000\ L_\odot$.

Object distance, d = 18 kpc; variable velocity field; nebular temperature, 15 k ≤ T_e ≤ 25 kK – ‹T_e› ≈ 21 kK.

Abundances (He, C, N, O, Ne): 10.88, 7.90, 7.47:, 6.74, 6.96 (given in the unit [12 + log X/H])

Also see: Schönberner et al. 2010, A&A, submitted

Stasińska et al. 2010, A&A, 511, A44
(also see the poster by Morisset et al.)

Use CLOUDY_3D – three-dimensional, hydrostatic, accounts for expansion cooling artificially

Consider the stellar binary component as well as the nebular component.

Two stars: $M = 0.5$–$0.6\ M_\odot$, $T_{eff} = 55$ kK, $L = 1700\ L_\odot$; (X-ray) $M = 0.8$–$0.9\ M_\odot$, $T_{eff} = 170$ kK, $L = 2500\ L_\odot$.

Distance, d = 24 kpc; constant velocity field, $v_{exp} = 30$ km/s; mean nebular temperature $T_e = 30$ kK(?)

Abund. (He, C, N, O, Ne): $10.95_{\pm0.04}$, $7.84_{\pm0.30}$, $7.15_{\pm0.25}$, $6.82_{\pm0.33}$, $6.83_{\pm0.30}$ (given in the unit [12+log X/H])

Also see: Tovmassian et al. 2010, ApJ, 714, 178

PN G135.9+55.9 is difficult to observe and to model. Further studies are needed to understand differences.