NUMERICAL GAS-DYNAMIC INVESTIGATION OF THE WHIMPER MODEL FOR THE
FORMATION OF PLANETARY NEBULAE

C.R. Purton
Dominion Radio Astrophysical Observatory, Penticton, B.C.,
Canada

The suggestion that the shells of planetary nebulae may be formed
at the interface between two stellar winds of different velocity ("Not
with a bang, but a whimper") (Kwok, Purton and FitzGerald, 1978,
Astrophys. J. 219, L 125) is investigated using the 'beam scheme'
(Sanders and Prendergast, 1974, Astrophys. J. 188, 489) adapted to a
system with spherical symmetry. Initial conditions include the remnant
wind from the red giant phase ($\dot{M} = 10^{-5}$ $M_\odot$ y^{-1}, $V = 10$ km s^{-1}) and a high-
speed wind from the hot nucleus ($\dot{m} = 10^{-6\odot}/ 10^{-7}$ $M_\odot$ y^{-1} (two tests),
$v = 10^3$km s^{-1}). The collision began at a radial distance of 200 AU.
A third test at 50 AU indicated that the end result was insensitive to
the details of the transition from one mass-loss mechanism to the other.

The shell formed at the interface increased in radius and mass:
after several thousand years it had the characteristics of a
conventional idealised planetary nebula. Calculated expansion velocities
were in the range observed, and increased slowly with time. Temperatures
of 2.5×10^7 K were found for the gas inside the shell, producing weak
but observable (at 1 kpc) X-ray emission. λ 4686 emission produced by
collisional ionization was found to be as strong as H$_\beta$ emission at the
later epochs. The radio spectrum at T = 100 y resembled Hb 12, at
T = 500 y a conventional 'optically thick' planetary, and after a few
thousand years became optically thin.

Stellar mass loss, both components, clearly have a profound effect
on the dynamics of a planetary nebula. It may not be necessary to
invoke any sudden ejection for the formation of a planetary nebula; it
may be the natural consequence of ordinary mass-loss processes in the
two stages of the star's evolution.

ISAACMAN: The model predicts the presence of 10^4 K gas with a density
  of about 10^3 cm^{-3} outside the shell. This seems inconsistent with
  observations of H$_2$ in several PN, as H$_2$ is presumably shock-excited
  by the expanding shell but dissociates at a few thousand K.
PURTON: The model assumes the gas to be ionized. A more realistic
  approach would be to follow the ionization front through the gas.

TARTER: I believe that X-ray line cooling will dominate bremsstrahlung
    at temperatures of 10^6 K. The diffuse emission in X-rays could have
    an observable effect on high ionization trace species such as Fe XIV.
DOPITA: The enhancement of X-ray cooling of the hot gas in non-
    equilibrium ionization conditions cannot be neglected. The large
    ionization time-scale of hydrogen- and helium-like ions ensures that
    a large amount of collisional excitation of their lines occurs. This
    raises the emissivity to about 30 times the equilibrium value.

HBV 475 AS A CANDIDATE PROTO-PN

S. Tamura
Astronomical Institute, Tohoku University, Sendai, Japan

The symbiotic nature of this object has been investigated by
optical spectroscopy and photometry in the near infrared region. There
are three components, which are (i) the ionized expanding envelope
consisting of two layers of low and high excitation species, (ii) the
late type component corresponding to a blackbody of 2500 K and
indicated by TiO absorption band, (iii) the hot remnant star whose
temperature is estimated indirectly as 150 000 K or more.

Recently a high dispersion spectrum with self scanning diode array
detector was obtained. If we assume circular motions in the Galactic
plane, we can estimate the distance as 9 kpc with the aid of the radial
velocity. In this spectrum, we can also clearly see Fe I absorption
lines (λ 4325.8, 4383.6, 4404.8) shifted to the violet by about 10 Å
(= -750 km s^{-1}) as well as broad Hγ and $\left(O\ III\right)$ λ 4363 emission lines.
In order to interpret these absorption lines, a single star hypothesis
may be preferable.

On the basis of IR photometry and radio data, the dimensions of
both the ionized expanding envelope and the late type component can be
estimated. It should be considered that the late type component is
extremely small and perhaps is embedded in the ionized expanding
envelope.

To explain the observed data, a schematic model is proposed.
(Papers will appear in Publ. Astron. Soc. Japan).