RevMexAA (Serie de Conferencias), **40**, 191–191 (2011)

KINEMATICAL STUDY OF THE PLANETARY NEBULA NGC 6058

P. F. Guillén,[1] R. Vázquez,[1] S. Zavala,[2] L. F. Miranda,[3,4] M. E. Contreras,[1] S. Ayala,[5] and S. Gil[1]

We have performed a morpho-kinematic analysis of the planetary nebula NGC 6058 based on direct imaging, high dispersion spectroscopy and the modeling tool SHAPE ver.3.5. NGC 6058 can be described as a high-excitation multipolar PN that consists of four ellipsoids oriented in different directions with similar inclinations with respect to the plane of the sky. We have also found point symmetric knots that trace the edges of the largest ellipsoid. A precesing collimated outflow might be a reasonable origin for the present structure of this nebula. We propose that NGC 6058 is probably an advanced stage of a "starfish" PN.

We have reconstructed the three-dimensional structure of NGC 6058 using the modeling tool SHAPE (Steffen et al. 2011). For this model we have considered that the different structures represent the projection of four oblate ellipsoids. We note that all these structures expand from a common center. For the model, we considered an homologous velocity law for the expansion motion of each structure. Using the SHAPE (ver. 3.5) kinematical tools, we have estimated polar and equatorial velocities for all ellipsoids (averaging around $v_p \simeq 38$ km s^{-1}, $v_e \simeq 69$ km s^{-1}), and inclination angles of the four major axes ranging from 77 to 90 degrees, respect to the line of sight. Adopting an average distance value of 3.5 kpc (Cahn 1992; Tajitsu & Tamura 1998), we have estimated the physical size of each one of the ellipsoids. We have also estimated their corresponding kinematical ages which range between 4700 and 5600 years. In addition to the kinematics, the image ratio [O III]-to-Hα was performed. According to Medina et al. (2009), the presence of a thin "skin" of [O III] emission surrounding an Hα layer could indicate that the formation of NGC 6058 is due to a series of collimated flows. An analogy could be made with the morphology seen in the young and compact planetary nebulae He 2-47 and M 1-37, observed by the *Hubble Space Telescope* and described by Sahai (2000). These young PNe could evolve to the morphology of NGC 6058 if we assume that the polar velocity suffered a slowdown over the equatorial velocity, in other words if the polar to equatorial ratio is decreasing over time. One possible mechanism to explain it, could be the interaction of polar caps with an external and dense gas halo, producing a deceleration along that direction. More research must be done in order to investigate whether this hypothesis or others are likely to produce the observed effects.

This project has been supported by PAPIIT-UNAM grants IN111903 and IN109509, and by CONACYT grant 45848. LFM acknowledges support from grant AYA2008-01934 of the Spanish Ministerio de Ciencia e Innovación (MICINN) and by Junta de Andalucía grant FQM1747. SZ acknowledge support from the UNAM-ITE collaboration agreement 1500-479-3-V-04.

REFERENCES

Cahn, J. H., Kaler, J. B., & Stanghellini, L. 1992, A&A, 94, 399
Medina, J. J., Guerrero, M. A., Luridiana, V., Miranda, L. F., Riera, A., & Velázquez, P. F. 2009, in Asymmetrical Planetary Nebulae IV, ed. R. L. M. Corradi, A. Manchado, & N. Soker (La Palma: IAC) `http://www.iac.es/proyecto/apn4/pages/proceedings.php`
Sahai, R. 2000, ApJ, 537, L43
Steffen, W., Koning, N., Wenger, S., Morisset, C., & Magnor, M. 2011, IEEE Trans. Visual Computer Graph., 17, 454
Tajitsu, A., & Tamura, S. 1998, ApJ, 115, 1989

[1]Instituto de Astronomía, Universidad Nacional Autónoma de México, Apdo. Postal 877, 22800 Ensenada, B. C., Mexico (fguillen@astro.unam.mx).
[2]Instituto Tecnológico de Ensenada, Blvd. Tecnológico No. 150, 22780 Ensenada, B. C., Mexico.
[3]Instituto de Astrofísica de Andalucía-CSIC, Camino Bajo de Huetor 50, E-18008 Granada, Spain.
[4]Departamento de Física Aplicada, Facultade de Ciencias, Universidade de Vigo, E-36310 Vigo, Spain.
[5]Instituto de Estudios Avanzados de Baja California A. C., Apdo. Postal 75, 22831 Ensenada, B. C., Mexico.