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Emission Lines of Northern Planetary Nebulae

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Abstract. In this work, we present results of long slit spectrophotometric emission line flux observations of selected planetary nebulae (PNe). We have measured absolute fluxes and equivalent widths (EW) of all observable emission lines. In addition to these observations, electron temperatures (Te), densities (Ne), and chemical abundances were also calculated. The main purpose of this work is to fill the gaps in emission line flux standards for the northern hemisphere. It is expected that the measured fluxes would be used as standard data set for further photometric and spectrometric measurements of HII regions, supernova remnants etc.

Keywords. planetary nebulae: general; techniques: spectroscopic; techniques: image processing

1. Introduction

Planetary Nebulae (PNe) are the final stage of stellar evolution for progenitors have masses between 0.8 $M_\odot$ and 8 $M_\odot$. This stage comes from post-AGB or proto-planetary nebulae (PPN) after the envelope is ejected to the interstellar medium leaving hot white dwarfs at the central part of PNe. They also enrich the interstellar medium with the ejected material. Thus, obtaining chemical abundances of PNe is essential to our understanding of the galaxy and its evolution. In the past, there were several works that they have relied on standard star observations using broad band photometry of spectrophotometry, or even using photon counting detectors. Since PNe release emission lines due to hot and low density gas, spectroscopy is the key to understand the properties of them. Dopita & Hua (1995) made slitless spectrophotometric observations of southern compact PNe, using the catalogue of Acker *et al.* 1992. Later, Wright *et al.* 2005 measured the emission line fluxes for northern hemisphere with only 6 PNe targets. Aim of this work is to increase the emission line standards in the northern hemisphere.

2. Observation strategy

Our target list of PNe were chosen from the catalog of Acker *et al.* 1992. The catalog contains 1142 PNe. The following criteria were used to select suitable targets:

(*a*) First, we selected PNe located in northern hemisphere DEC (δ) > -35 degree. This reduced the total number to 838.

(*b*) Then, the catalog is filtered with RA (α) in between 7h and 12h. This reduced the total number to 805 PNe.

(*c*) From this subset, PNe with angular size < 5 arcsec are selected (i.e. PNe size fitting to the available slits at the observatory). This reduced the total number to 276 PNe.

(*d*) Among this subset only 12 less studied PNe were selected.

(*e*) 5 PNe from Wright *et al.* 2005 were also added to this subset which increased the total number to 17.

3. Instrumentation

A subset of PNe was first observed with TUBITAK National Observatory's (TUG) T100 telescope to obtain visual magnitudes so that further spectroscopic exposure times could accurately be determined. TFOSC (TÜBİTAK Faint Object Spectrometer and Camera coupled with the 150 cm Russian–Turkish Telescope (RTT150)) We have used different slits for different PNe: 3.5 arcsec for point-like objects and 7.3 arcsec for wider objects.

4. Summary

In this work we have measured emission line fluxes and their equivalent widths of 17 PNe. Their physical and chemical properties were also calculated. Observed H_β fluxes of the PNe were compared with Acker *et al.* 1992. An explicit linear relation exists between Acker *et al.* 1992 and our works A similar relation was also found for Wright *et al.* 2005. The error in flux measurement of each emission line is less than 1% of the line strength. In addition to this, low SNR of the spectra on relatively bad seeing conditions produced slit losses which accumulated to no more than 10% of the signal, therefore causing a relatively low flux value. With this work the northern hemisphere coverage of PNe is extended by carrying out similar studies done by Dopita & Hua (1995) (for southern hemisphere) and Wright *et al.* 2005 (for northern hemisphere). We present new emission line fluxes which can be counted as standards for both narrow band imaging and Fabry-Perot spectroscopy. Extinction constant, electron temperature, electron density, chemical abundance and excitation class have been calculated for suitable PNe (see Aksaker *et al.* 2015 for further details).

5. Acknowledgement

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