Recycling Intergalactic and Interstellar Matter
IAU Symposium Series, Vol. 217, 2004
Pierre-Alain Duc, Jonathan Braine and Elias Brinks, eds.

Flux Ratio [Ne V] 14.3/24.3 as a Test of Collision Strengths

Rubin, R. H.

NASA Ames Research Center, Moffett Field, CA 94035–1000, USA

Abstract. From ISO [Ne V] 14.3/24.3 μm line flux ratios, we find that 10 out of 20 planetary nebulae (PNs) have measured ratios below the low-electron density (N_e) theoretical predicted limit. Such astronomical data serve to provide important tests of atomic data, collision strengths in this case. In principle, well-calibrated measurements of the [Ne V] 14.3/24.3 flux ratio could improve upon the existing atomic data.

1. Introduction

In an earlier study of PNs with Infrared Space Observatory (ISO) observations, Rubin et al. (2001) found evidence that the useful N_e diagnostic line flux ratio [Ne V] F(14.3 μm)/F(24.3 μm) was out of range of theoretical predictions using current atomic data. In particular, NGC 6818 with a measured flux ratio of 0.71 was significantly out of bounds in the low-N_e limit. Thus N_e could not be derived; we concluded that perhaps the calculations of the effective collision strengths for these lines should be revisited. Now we include all PNs in the ISO archive that have both lines well measured.

2. Results, discussion, and conclusions

Table 1 presents our results. The last column has the derived N_e or an $*$ when the flux ratio is out of bounds in the low-N_e limit (see figure 5 and table 6 in Rubin et al. 2001) based on the effective collision strength from Lennon & Burke (1994). Using more recent values from Griffin & Badnell (2000), the discrepancy is somewhat less but still present.

- Ten out of 20 PNs and 15 of the 28 PN ISO/TDTs (TDT # identifies an observation) in the Table yield [Ne V] F(14.3)/F(24.3) below the low-N_e theoretical limit. While there might be systematic errors affecting the ISO data, we note that the observed aperture sizes match for this line pair. The low-N_e limit is governed by the effective collision strengths. We believe this work points to the need to reevaluate the effective collision strengths for this ion.
- Even when the line flux ratio is within "legal bounds", as is the case for the 3 symbiotic stars (HM Sge, RR Tel, and V 1016 Cyg) included in the Table, and a value for N_e may be obtained, if the collision strengths are to be revised as indicated by much of the data here, then these derived N_e values are likely to require a revision upward.

Table 1. Flux Measurements for [Ne V] 14.3 and 24.3 μm Lines

Name	ISO TDT#	SWS mode	Exp Time (sec)	F(14) (Watts cm^{-2})	F(24) (Watts cm^{-2})	F(14)/ F(24)	N_e (cm^{-3})
H 1-36	32400609	1	1140	1.65E-18	5.97E-19	2.76	11600
Hb 5	49400104	1	3454	3.03E-17	1.47E-17	2.06	6520
He 2-111	60700111	2	1828	1.77E-18	2.58E-18	0.683	*
HM Sge	31901701	1	1140	1.44E-18	4.58E-19	3.15	15000
Hu 1-2	35801255	1	1912	2.38E-18	1.49E-18	1.60	3680
	54001009	2	1828	1.17E-18	1.47E-18	0.790	*
IC 2165	70201606	2	5084	2.40E-18	2.10E-18	1.14	1180
Me 2-1	62803316	2	1828	1.07E-18	1.34E-18	0.794	*
NGC 2022	69702701	2	1828	1.70E-18	2.21E-18	0.770	*
	69201703	2	5084	1.37E-18	1.72E-18	0.801	*
NGC 2440	72501762	1	1912	9.30E-19	1.16E-18	0.801	*
NGC 3918	29900201	1	1140	5.15E-18	5.94E-18	0.868	*
NGC 5189	31800125	1	1140	1.64E-19	3.47E-19	0.473	*
NGC 6302	9400716	1	6528	6.69E-17	2.98E-17	2.24	7760
	28902017	2	2544	2.09E-17	1.50E-17	1.39	2520
NGC 6445	48700507	1	1912	1.90E-18	2.30E-18	0.825	*
	48700403	2	1828	1.74E-18	2.09E-18	0.833	*
NGC 6537	70300475	1	3454	2.48E-17	1.70E-17	1.46	2860
	47000722#	1	1912	2.47E-18	1.74E-18	1.42	2690
NGC 6720	36600207	1	1140	1.41E-19	3.33E-19	0.424	*
NGC 6741	48001305	2	1828	2.42E-18	2.20E-18	1.10	960
	13401806	1	1062	1.86E-18	2.12E-18	0.877	*
NGC 6765	73600222	1	6538	2.69E-19	4.15E-19	0.648	*
NGC 6818	34301004	2	4854	3.98E-18	5.34E-18	0.744	*
NGC 6886	13400810	1	1062	1.66E-18	1.73E-18	0.959	260
	53701808	2	1828	2.30E-18	2.10E-18	1.10	950
NGC 7027	55800537	1	6537	1.25E-16	3.49E-17	3.59	19000
NGC 7662	75101722	2	1562	2.49E-18	2.55E-18	0.975	340
	43700427	1	1912	1.89E-18	2.50E-18	0.756	*
RR Tel	54601404	2	1026	6.72E-19	1.98E-19	3.39	16200
V1016 Cyg	55102706	1	1140	6.65E-19	2.19E-19	3.03	14100
	55102705	2	1628	7.56E-19	2.39E-19	3.16	15100

* Observed flux ratio is below the low-N_e theoretical limit.
# Position different by ~20″ in FOV 33″ × 20″.
Note: *HM Sge*, *RR Tel*, and *V1016 Cyg* are symbiotic stars.

Acknowledgments. RHR acknowledges support from the NASA Long-Term Space Astrophysics (LTSA) program.

References

Griffin, D.C., & Badnell, N.R. 2000, J. Phys. B, 33, 4389

Lennon, D.J., & Burke, V.M. 1994, A&AS, 103, 273

Rubin, R.H., Dufour, R.J., Geballe, T.R., Colgan, S.W.J., Harrington, J.P., Lord, S.D, Liao, A.L., & Levine, D.A. 2001, in Spectroscopic Challenges of Photoionized Plasmas, ASP Conference series, Vol. 247, Eds. G.J. Ferland & D.W. Savin, p. 479 (astro-ph/0109398)

https://doi.org/10.1017/S0074180900197426 Published online by Cambridge University Press