Spectral Line Intensity Variations in Planetary Nebulae

Evans, Catchpole and Jones[1] recently suggested that the small southern planetary nebula, *IC* 4642, shows striking spectral changes. They compared eye estimates of intensity on low dispersion spectrograms with low-resolution scanner measurements published by Aller and Faulkner[2].

These lines fall in a crowded region, which, if observed with a resolution of 24–40 Å, would produce a blurred line that easily could be misinterpreted as "λ3727". Summing the line intensities from λ3703 to λ3759 we obtain "36" on the scale $I(H\beta)=100$ which is to be compared with the 46 quoted by Aller and Faulkner.

We are not convinced that spectral changes have actually occurred in *IC* 4642 on the basis of available observations. Further careful studies are needed for this object, which is one of the highest excitation planetaries known.

Table 1. MEASURED LINE INTENSITIES IN THE SPECTRUM OF *IC* 4642

λ	Ident.	PG	PE	λ	Ident.	PG	PE	λ	Ident.	PG	PE
3132·9	OIII	57·5		3734·3	H13	3·4		4101·7	Hδ	36	41
3203·1	HeII	70		3750·1	H12	3·8		4199·8	HeII	3·6	
3312·3	OIII	11		3754·6	OIII	4·9		4267·1	CII	1·8	
3340·8	OIII	13		3759·8	OIII	4·8		4340·6	Hγ	55	47
3345·9	[NeV]	67	55	3770·6	HII	6·5		4363·2	[OIII]	16	23
3426·0	[NeV]	143	170	3797·8	H10	7·8		4541·4	HeII	5·4	
3428·6	OIII	4·5		3835·3	H9	13·5		4685·7	HeII	112	142
3444·0	OIII	16·3		3868·8	[NeIII]	56	67	4711·4	[ArIV]	15	
3703·8	H16	2·8		3889·9	H8, He	16·4		4724·3, 4725·7	[NeIV]	3·8	
3712·0	H15	3·0		3967·5	[NeIII]	11	29	4740·0	[ArIV]	12	
3721·9	H14	4·0		3970·0	Hε	18		4861·3	Hβ	100	100
3726·0	[OII]	4·4	46	4026·0	HeII	2·9		4959·0	[OIII]	155	200
3728·7	[OII]	4·5		4068·6	[SII]	2·3		5006·9	[OIII]	450	600

Aller and Faulkner emphasized the necessity of combining spectral scans with ordinary spectrograms of adequate resolution (see their Fig. 2). We have therefore undertaken photographic spectrophotometric measurements of a number of southern planetaries with the 60 inch reflector at Cerro Tololo in Chile. We calibrated the plates with a spot sensitometer and filters, and spectra of θ Crateris secured with a very wide slit. We used the spectral energy distribution as measured by Hayes[3], who used Vega as his fundamental comparison star. These results are in good agreement with those of Oke[4] and of Aller, Faulkner and Norton[5] when allowance is made for the revised energy distribution for Vega. The dispersion was about 76 Å mm^{-1}.

The columns headed PG in Table 1 give the intensities derived from three separate exposures and the columns headed PE quote the photoelectric results from Aller and Faulkner. Except for λ3727 [OII], the results are comparable. The differences can be attributed to noise difficulties in photographic photometry and to uncertainties in locating the continuum. Fig. 1 is a reproduction of part of a tracing in the region of λ3727. The numbers on the right give the relative intensity scale and the dotted line the estimated position of the continuum. The 3727 [OII] pair seems to be present from May 17, 1968.

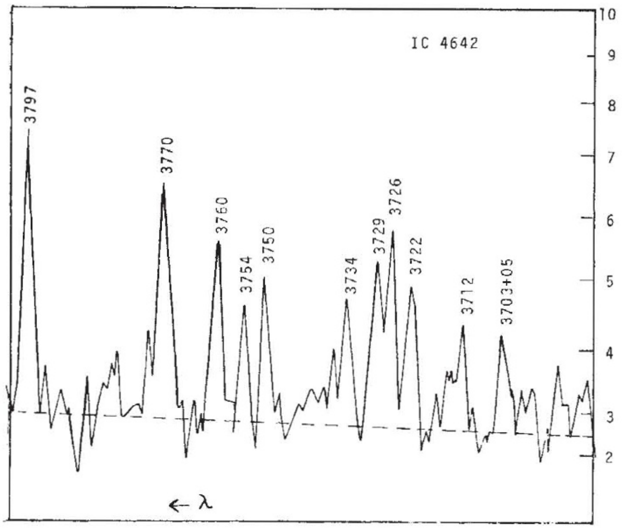

Fig. 1. Spectrum of *IC* 4642 in the region λ3727.

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LAWRENCE H. ALLER

Radiophysics Laboratory,
CSIRO, Sydney.

GORDON WARES

Air Force Cambridge Laboratory,
Hanscom Field,
Massachusetts.

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Model Atmosphere Calculation of the Solar Oblateness

Dicke and Goldenberg[1] measured the difference between the polar and the equatorial flux coming from the limb of the Sun (ΔF), and inferred that the surface of equal potential at the limb is oblate by 35 km. The Sun thus has a quadrupole moment due to a rapidly rotating interior, producing a perihelion shift of Mercury of 3·4 s of arc century^{-1}. Agreement between the value predicted by general relativity and the observed perihelion shift of Mercury is thus destroyed. One of us[2] has criticized the Dicke and Goldenberg interpretation and has suggested that the flux difference is due to a stronger stabilization of convection, by rotation, at the pole.

The two basic assumptions made by Dicke and Goldenberg are that the surfaces of equal density and potential coincide, and that, if ΔF is due to a temperature difference, the difference in flux divided by the flux remains constant when the slit size used to measure the flux difference is increased. Here we shall examine the latter assumption more closely.

Assuming that convection is preferentially stabilized at the pole, temperature differences between pole and equator will drive currents which convect more flux at