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PHOTOIONIZATION MODEL FOR G29.96–0.02

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RESUMEN

Presentamos un modelo de fotoionización detallado de la región H II ultracompacta (UCH II) G29.96–0.02 basado en el espectro combinado de los instrumentos SWS y LWS a bordo del ISO. Las intensidades de la mayor parte de las líneas observadas son reproducidas cuando G29.96–0.02 es descrita como una nebulosa con dos regiones de diferente densidad. Encontramos que la estrella ionizante es más fría que el tipo espectral predicho mediante observaciones en el infrarrojo cercano y que su edad es $\approx 3 \times 10^6$ años, es decir, mayor al tiempo típico de vida de las regiones UCH II. Las abundancias de los elementos principales son determinadas con precisión.

ABSTRACT

We present a detailed photoionization model of the Ultra Compact H II (UCH II) region G29.96–0.02 based on the combined *ISO* SWS and LWS spectrum. Most of the observed line intensities are reproduced when G29.96–0.02 is described by a nebula with two different density regimes. We find that the ionizing star is cooler than the spectral type determined from near-IR measurements and that its age is $\approx 3 \times 10^6$ yr, i.e., older than the expected lifetime of UCH II regions. Accurate abundances for the main elements are derived.

Key Words: **H II REGIONS — ISM: INDIVIDUAL (G29.96–0.02, IRAS18434–0242)**

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1. INTRODUCTION

The *ISO* UCH II Catalogue consists of combined SWS and LWS spectra of 43 Galactic UCH II regions (Peeters et al. 2001). The major aim of this catalogue is to provide high quality infrared spectra to study the ionization state and the abundance variation across the Galactic disk (Martín-Hernández et al. 2001). For some of the sources up to 16 atomic fine structure lines are available together with many hydrogen recombination lines. Amongst these sources is G29.96−0.02 (IRAS 18434−0242), a well-known bright and compact ($\approx 7''$) radio source (Wood & Churchwell 1989). It has been selected as a template for a close examination of the characteristics of the ionized gas, to constrain the properties of the central exciting star and to derive accurately the elemental abundances.

2. MODELING

The cometary shape of G29.96–0.02 seen in radio maps (Wood & Churchwell 1989) suggests a core/halo morphology and hence two density regimes. The low density region (the halo) is traced by the [O III] 88 and 52 μm lines which indicate an electronic density $n_e \approx 700$ cm^{-3} (Martín-Hernández et al. 2001). The high density gas (the bright core) has $n_e \approx (2–5) \times 10^4$ cm^{-3} as derived from radio data (Afflerbach et al. 1994). Both the high and low density gas have been modeled using the photoionization code *NEBU* (Morisset & Péquignot 1996). The final model adds these two components with appropriate weighting factors. The ionizing photon distribution is taken from the recent CoStar models (Schaerer & de Koter 1997), which treat non-LTE and line blanketing effects and the stellar wind.

3. RESULTS

The resulting parameters of the model are listed in Table 1 including the element abundances. The predicted line intensities and radio continuum flux densities are compared to the observed ones in Figure 1, where the contributions of the low and high density regions are highlighted. As can be seen from Fig. 1, most of the line intensities are well reproduced by the model. Note that since the convergence process uses only 10 out of the 16 observables, only 6 intensities are predictions. The fact that some of the lines are not well predicted can be understood as follows: the [S III] 33.6 μm and [Ne III] 36.0 μm lines are affected by severe calibration problems (Peeters et al. 2001), and for the [S IV] 10.5 μm line, which lies in the silicate absorption band, no correction for attenuation has been applied. The underestimation

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TABLE 1

PARAMETERS OF THE MODEL

Distance (kpc)	6.0	
Effective temp (kK)	29.7	
Luminosity (10^6 $L_\odot$)	1.08	
Inner radius (10^{17} cm)	3.0	
Dust/gas ratio	10^{-5}	
[He]/[H] (by number)	0.1	
[C]/[H]	1.00×10^{-4}	
[N]/[H]	1.90×10^{-4}	
[O]/[H]	4.50×10^{-4}	
[Ne]/[H]	1.70×10^{-4}	
[S]/[H]	2.20×10^{-5}	
[Ar]/[H]	4.80×10^{-6}	
	Comp. 1	Comp. 2
Inner $n_{\rm H}$ (cm^{-3})	620	52000
Fraction of emission	36%	64%
Filling factor	1.00	1.00

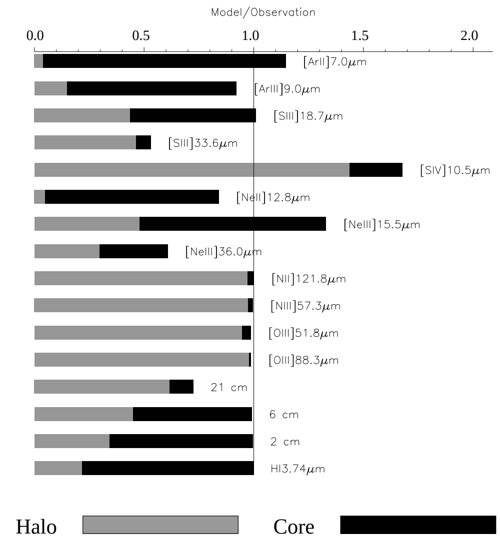

Fig. 1. Ratios of the modeled to observed line intensities and radio continuum flux densities. The line intensities are taken from Peeters et al. (2001).

of the 21-cm radio flux density may be due to the fact that part of the observed flux originates from a nearby source (Kim & Koo in this volume). For more details, see Morisset et al. (2001).

4. CONCLUSIONS

The Ultra-Compact H II region G29.96–0.02 has an extended component of low density which accounts for most of the intensity of the infrared lines with low critical density. The derived abundances are in agreement with the lower values of previous determinations (Simpson et al. 1995; Afflerbach et al. 1997). The effective temperature for the ionizing star using CoStar atmosphere models is estimated to be 30 ± 1 kK, i.e., lower by 10 kK than the value derived from near-IR observations (Watson & Hanson 1997). This result suggests that the Vacca et al. (1996) relation is overestimating the effective temperature for late O stars. The age of the exciting star is $\approx 3 \times 10^6$ yr and thus older than what is expected from the dynamical lifetime of UCH II regions.

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