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INTERNAL VARIATION OF ELECTRON DENSITY IN GALACTIC AND EXTRAGALACTIC HII REGIONS

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A systematic search for internal variation of the electron density in galactic and giant extragalactic H **II** regions (GEHRs) has been conducted on a sample of 32 objects of different sizes and evolutionary stages. The electron density indicator used was the [S II] $\lambda6716/\lambda6731$ line ratio. No systematic spatial density variation was found in nearly 50% of the galactic objects and 40% of the GEHRs. Internal variations of electron density were detected in the remaining objects.

The electron density, $N_{\rm e}$, is a parameter of fundamental importance to understand the physical processes and properties of H II regions. Usually a single value of electron density is assumed to characterize the whole nebula. In the case of a non-homogeneous object this procedure can potentially result in improper interpretation of the spectral data. We report the results of a study on the internal spatial variation of the electron density in H II regions. Long slit spectra of high signal-to-noise ratio were obtained for a sample of 15 galactic (Copetti et al. 2000) and 17 extragalactic (Castañeda et al. 1992; Copetti et al. 2001) objects of different sizes, surface brightness, morphologies and evolutionary stages. The observations were performed with the Cassegrain spectrographs attached to the 1.60 m telescope of the Laboratório Nacional de Astrofísica, Brazil, and to the 2.50 m Isaac Newton telescope at the Roque de Los Muchachos Observatory, La Palma, Canary Islands. The extragalactic H II regions studied belong to the galaxies M 33, M 51, M 101, NGC 2366, NGC 2403, NGC 4214, NGC 4449, NGC 4656 and NGC 6822. The galactic H II regions presented low mean electron densities of the order of $N_{\rm e} \approx 20$–360 cm^{-3}. The only exception was NGC 2579 with a peak density of $N_{\rm e} \approx 1700$ cm^{-3}. The mean densities of the individual GEHRs are in the range $10 < N_{\rm e} < 310$ cm^{-3}. The sample median values are $N_{\rm e} = 35$ cm^{-3} for the GEHRs and $N_{\rm e} = 131$ cm^{-3} for the galactic objects. No systematic spatial variation of electron density was found in nearly half the galactic objects (S 255, S 257, S 271, S 285, S 301, S 305, NGC 3372 and IC 1275) and in 40% of the GEHRs (NGC 595, NGC 2403 II, NGC 4656 I, NGC 5194-1, NGC 5194-4, NGC 5462, and NGC 6822-1). Internal variations of electron density were detected in the remaining galactic H II regions (S 288, S 307, NGC 2579, NGC 3503, Gum 62, Gum 64a and M 20) and GEHRs (NGC 604, NGC 2366 I, NGC 2403 I, NGC 4214 (center), NGC 4449-CM 22, NGC 5447, NGC 5455, NGC 5457, NGC 5461 and NGC 5471). In most of the cases, the spatial variation of density may be interpreted as a radial gradient with the density decreasing from the center to the edges. M 20 shows a systematic non-radial density variation with higher values occurring on its prominent dark lanes, maybe due to the compression of the ionized gas against the associated molecular clouds. Among the galactic objects, the only giant H II region observed was NGC 3372. At a spatial scale of 0.06 pc, this object presented low and homogeneous electron densities quite similar to those of many of the GEHR, which were observed at resolutions of 5 to 30 pc. The general results indicate that classic galactic H II regions have nearly the same electron densities than the GEHRs, but this conclusion must be taken with caution because the electron density sensor used in this work is more sensitive to the outer zones of the H II regions, so higher density may be found in the inner parts. Filling factors of the order of $\phi = 0.1$ were estimated for the galactic sample and in the range $0.002 < \phi < 0.5$ for the GEHRs. In some cases the density profiles seem to be compatible to the "blister" or "champagne" dynamical models.

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