NEAR INFRARED CATALOG OF GALACTIC HII REGIONS.

KINEMATICAL AND SPECTROPHOTOMETRIC DISTANCES

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Abstract

HII Regions are the best tracers of the arms of spiral galaxies. Deriving accurate distances to these objects is of fundamental importance. Distances to these objects can be derived with radio recombination line plus a galactic rotation model. However, this method suffers from classic near-far ambiguity. In this work, we present results based on K-band spectrophotometric data, and show discrepancies between these determinations and that based on kinematic methods. Our results (spectrophotometric distances) are systematically smaller than that obtained by kinematical techiniques.

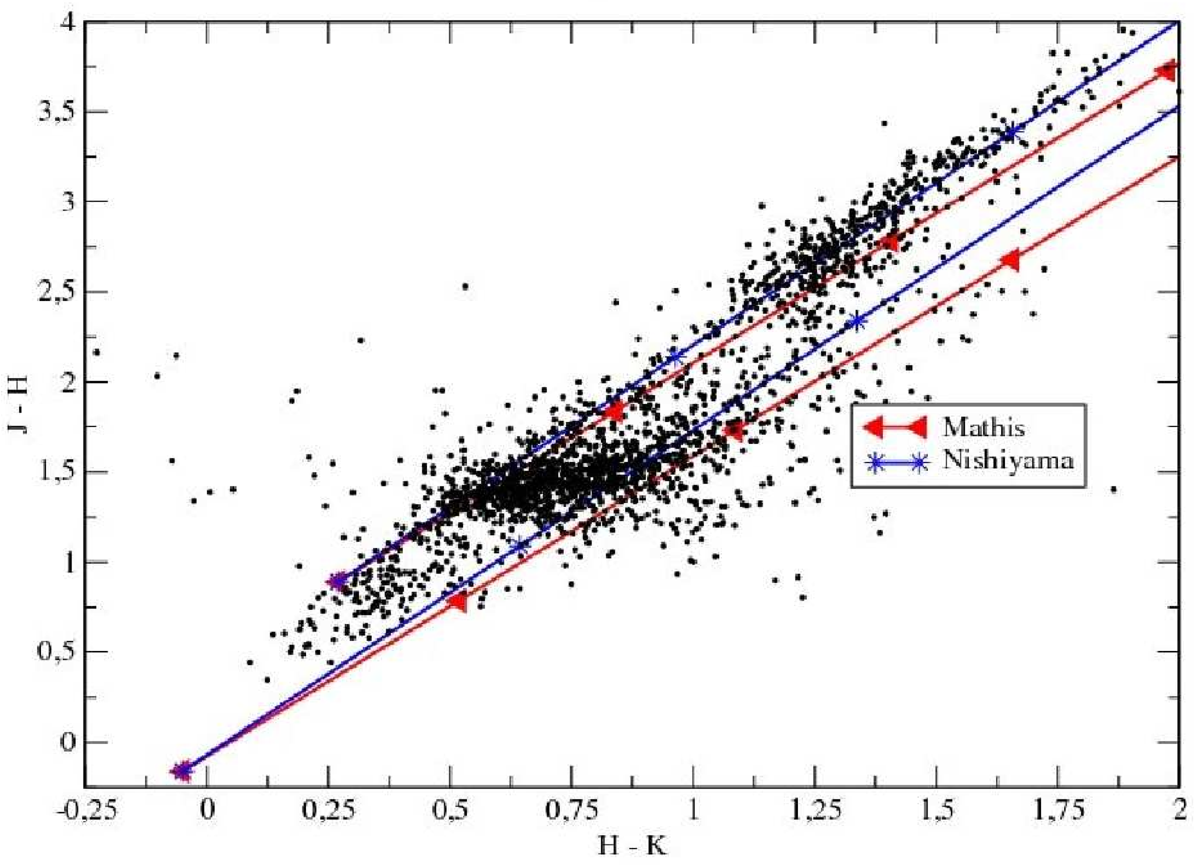
Goal

The Galactic spiral pattern is not well knwon, since it requires tracers with precise distance determinations. The best tracers of spiral arms are HII regions. However, the most common way to derive their distances is using radio recombination lines plus a galactic rotation model. Inside the solar circle, distances derived from these models are double-valued and there is a singularity towards the Galactic Center. Determinations that do not use rotation models are important to break this ambiguity. Spectrophotometric parallax is very robust to obtain the distance from a given star and, in our case, the distance to the host HII region. In this sense, a sample of accurate distances to galactic HII regions can be used to trace the spiral pattern of the Milky Way. With the development of NIR techniques, we are able to have access to distant HII regions, since the extinction in the infrared is lessen by a factor of ten when compared to that in the visual domain ($A_K \approx 0.1 A_V$).

Metodology

We have collected kinematic distances to a list of 11 HII regions (see the table) from Conti & Crowther (2004). We have used this list of objects to obtain JHK photometry to select the ionizing sources of the HII regions. These ionizing sources are the targets to obtain spectrophotometric distances. Indeed, we have obtained K-band spectroscopy of these targets. These spectra can be used to identify the spectral type of the stars, if their photosphere is naked. Following the scheme described in Hanson $et\ al.$ (1996) we have derived the spectrophotometric distances to their host HII regions. To see the influence of reddening in the distance determination, we have used two extreme interestellar extinction laws ($A_\lambda \propto \lambda^\alpha$) Mathis (1990) and Nishiyama $et\ al.$ (2006). Mathis (1990) derived a value of $\alpha = -1.70$, while Nishiyama obtained $\alpha = -1.99$. In the figure (CCD diagram), we can see the two extinction laws (lines) used in this work. This figure show us a color-color diagram, where we have plotted the colors of the stars (circles) found in the HII Region G353.19+0.64. Mathis'law are represented by the black lines, while Nishiyama's are the blue ones. The top lines are for M-type stars and the bottom lines are for O-type stars. In the figure, we can see the Nishiyama's law is fitting the data better than Mathis's law.

Color image of the HII Region: G353.19+0.64 (10'x10'). J is blue, H is green and K is red. North is up and East is to the left.



Color-color diagram (CCD). The points represent the stellar content of the HII Region: G353.19+0.64. The lines represent the reddening vectors. Mathis (1990) is represented by the blue lines, while Nishiyama et al. (2006) is represented by the red lines. In both cases, the top lines are the reddening vectors of M-type stars, while the bottom line are the reddening vectors of O-type stars.

Sample

Our sample is made of potential Giant Galactic HII (GHII) regions based on radio fluxes, FIR luminosities and kinematic distances (Conti & Crowther (2004)). An HII region is considered giant when the Lyman continuum luminosity is, at least, 10^{50} photons per second. Spectrophotometric distances of almost all regions are closer to the Sun than was predicted by kinematic distances. In the table, we compare the results from a galactic rotation model (kinematic, Russeil (2003)) and the two interstellar extinction laws (spectrophotometric).

Results

The table show us that spectrophotometric distances from Nishiyama's law are bigger than that derived with Mathis' law. This discrepancy with the kinematic distance is diminished, but not removed. Object W3OH has distance derived via $Trigonometric$ parallax (Xu $et\ al.$ (2006)) and via spectrophotometric parallax in the optical domain (Humphreys, 1978), both results give a distance of 2 kpc, while kinematical results give 4 kpc (Russeil, 2003). The distance of the object NGC3603 is derived from $Isochrones$. The spectrophotometric distances are smaller, implying in smaller N_{LyC} and Star Formation Rate (SFR).

Região	D_{Kin}	N_{Ly} (10^{50})	$D_{sp.}$ Mat	N_{Ly} (10^{50})	$D_{sp.}$ Nis	N_{Ly} (10^{50})
M8	2.8	1.55	0.8	0.14	0.9	0.16
W31	4.5	4.57	3.3	2.46	3.9	3.43
M17	2.4	16.6	1.6	7.4	1.7	8.33
W42	11.5	8.51	2.5	0.4	2.8	0.5
W43	6.2	6.76	4.7	3.88	6.3	6.98
W49A	11.8	16.22	10.9	13.84	14.7	25.17
W51A	5.5	8.71	2.9	2.42	4.0	4.61
W3OH	4.2	1.78	1.95	0.38	TrP	—
NGC3603	7.9	31.62	6.0	18.24	Is	—
G298.2-0.3	10.4	7.41	3.9	1.04	4.6	1.45
G333.1-0.4	3.5	1.2	3.1	0.94	3.3	1.07

Comparison between kinematical and spectrophotometric results. Column 1 show us the names of the objects. Columns 2 and 3 are the kinematic distances and the number of photons in the Lyman continuum (N_{LyC}) used in Conti & Crowther (2004). Columns 4 and 5 are the spectrophotometric distances using A_K from Mathis (1990) and the reciprocal N_{LyC}. Columns 6 and 7 are the same results as columns 4 and 5, but using A_K from Nishiyama $et\ al.$ (2006).