University of Groningen

Far infrared observations of galactic HII regions

Olthof, Hindericus

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
1975

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):
Olthof, H. (1975). *Far infrared observations of galactic HII regions*. s.n.

Copyright
Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license. More information can be found on the University of Groningen website: https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment.

Take-down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): http://www.rug.nl/research/portal. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Download date: 12-10-2022

VIII. SUMMARY AND CONCLUSIONS

This thesis has presented a far infrared photometric survey of HII regions in the galactic plane between $\ell^{II} = 350^o$ and 35^o. The results discussed and analysed here have been obtained with a balloon-borne gondola, containing two 20 cm f/6 telescopes with a field of view of 0.5 degree, launched in cooperation with the French Space Research Organisation C.N.E.S. Jupiter was observed for calibration purposes throughout.

The fluxes we have observed are generally factors two to four higher than the results obtained by Hoffmann et al (1971) on the same sources using a balloon-borne telescope with a 0.2 degree beam. The differences in the results obtained are mainly due to differences in beam sizes. The beam switching technique, which detects the differential of the source flux distribution and has necessarily to be used in far infrared astronomical observations from the ground, aeroplanes and balloon-borne gondolas, is insensitive to small flux gradients and tends to lead to an underestimate of the flux from the whole source. Observations with large beams give a much better determination of the total flux emitted by extended sources.

As was discussed in chapter II, it seems reasonable to explain the far infrared emission from HII regions in terms of radiating dust grains, distributed within and around the nebulae and in thermal equilibrium with the radiation field.

The observations were carried out in two wavelength bands simultaneously, which allows us to derive the temperature of the emitting dust once we have assumed a specific wavelength dependence of the absorption efficiency of the particles in question. In this case we have chosen to assume an absorption efficiency $Q_\lambda \propto \lambda^{-n}$ where n = 1 (Mie scattering) and n = 2 (harmonic oscillator). The temperature so derived does not depend strongly on the choice of n, although the temperatures for n = 2 are always lower than for n = 1. In general we find dust temperatures derived by this method to range between 20 and 60 K. This may indicate that the properties of the dust are approximately the same for all HII regions. These temperatures are lower than the dust temperatures derived by Frogel and Persson (1974) from observations of HII regions at 10μ and 20μ. This may further lead us to the conclusion that the main part of the far infrared emission originates from the cooler outer regions of the dust distribution. The far infrared observations available until the present time have not been made with sufficient angular resolution to confirm this conclusion.

Using the temperatures derived as indicated above we have calculated integrated infrared fluxes, total luminosities, masses of the dust, and dust to gas ratios, for each observed HII region.

The integrated infrared fluxes are almost independent of the choice of n. The uncertainty in the temperature of the dust can account for the difference in integrated infrared fluxes. If nebulae are optically thick to ultraviolet and visual stellar radiation the integrated fluxes are representative of the total emission of the stellar population, which is responsible for the ionization of the gas and the heating of the dust. The dust distributed within and around HII regions acts as a wavelength transformer for much of the energy output of the stellar population. Part of the heating of the dust grains may result from absorption of Lyman-α photons produced in the maintenance of the ionization equilibrium within the gas. This mechanism alone is for most nebulae insufficient to account for the integrated infrared fluxes. Additional heating due to absorption of stellar photons depends on the ratio between the optical depths for absorption of these photons by the gas and by the dust.

For most sources the total luminosity can be explained by a stellar population with absolute magnitudes distributed according to the initial luminosity function. This function is derived from the distribution of stars as found in young clusters in the solar neighbourhood. It may be questionable whether this relation also holds for the more central regions of the galaxy. Apart from the galactic centre we do not observe sources with a total luminosity greater than

10^7 $L_\odot$(i.e., comparable to a star cluster with brightest member one O5 star). This may indicate that the initial luminosity function is a realistic representation of the distribution of stellar luminosities everywhere in the galaxy where stars have recently been formed.

The estimated masses of the dust and the derived dust to gas ratio depend strongly on the choice of n. For n = 1 it is evident from the results in chapter VII that the average dust to gas ratio is of the same order of magnitude or less than in the general interstellar medium (10^{-2}). For n = 2 much higher dust masses are necessary to account for the total emitted energy. This, however, strongly depends on the resonances in the chemical composition of the particles that determine the infrared absorption cross section. High resolution spectral observations above 20μ are necessary to detect the absorption features such as those expected by Aanestad (1975). In addition more accurate observations in the spectral region well above the absorption features (> 100μ) are necessary to determine the shape of the spectrum.

In chapter III we derived estimates for the fluxes of far infrared forbidden transitions in ions of heavy elements. Observations of these lines can add substantially to our knowledge of the physical conditions in HII regions. Because the transition probabilities of these forbidden lines are small, self-absorption in the lines is unimportant. This means that the gaseous component of the nebulae will be optically thin to forbidden line radiation so that the observed fluxes are directly proportional to the ionic abundances. Observation of the flux ratio of forbidden lines from different stages of ionization give the abundance ratio of these ions immediately. On the other hand, the distribution of ionization stages of heavy elements (e.g., C, N, O, etc.) is in general completely determined by the radiation field of the stellar population or the HII regions. If this stellar radiation field is diluted due to the absorption of ionizing photons by the dust this will directly affect the ionization equilibrium of heavy elements. Observations of these lines could well be a crucial factor in the denial or support of the present weak evidence (derived from the radio recombination lines of He) for the absorption of Lyman continuum photons by the dust.