

PRINCETON UNIVERSITY OBSERVATORY

PRINCETON, NEW JERSEY 08540

PEYTON HALL

February 24, 1967

Dr. G. R. A. Ellis  
 Department of Physics  
 University of Tasmania  
 Hobart, Tasmania

Dear Dr. Ellis:

During the last six months I have been working on the draft of a graduate text on interstellar matter. In this connection I have been very much interested to study your important work with Hamilton on absorption of radio waves by ionized gas in the galactic disc. I wrote Dr. Hamilton from Paris several months ago, raising several questions on your most recent joint paper, in Ap. J., 146, 78, 1966. However, I have received no reply - perhaps my letter never reached him. Hence I am writing to you in the hope you can answer my questions.

The major question I would like to raise concerns the opacity formula you use for free-free absorption. Your optical thickness is essentially  $yL/f^2$ , where

$$y = 2 \xi N_T^2 T^{-3/2} \quad (1)$$

and where you let  $\xi$  equal 0.16. According to equations (5-58) and (5-59) in my book, Physics of Fully Ionized Gases (2nd edition), if one includes stimulated emission in the absorption coefficient and evaluates the Elwert-Scheuer formula for the Gaunt factor, one obtains, in your notation

$$y = 0.17 N_T^2 T^{-3/2} \left( 1 + 0.13 \log \frac{T^{3/2}}{f^2} \right) \quad (2)$$

Essentially this same formula was given by Hamilton at the Mt. Stromlo 1966 Symposium - p. 95 of the typed Proceedings.

With  $\xi$  set equal to 0.16, your formula for the optical thickness exceeds that obtained from equation (2) by about a factor 2. I am wondering if you have taken into account some effect that I have overlooked. Perhaps you have used a more recent evaluation of the Gaunt factor. Since I am anxious to give the correct formula for opacity in my book, I should appreciate your enlightening me as to the source of your opacity.

In going over your analysis of the data, I have not been sure of the units for X in the six diagrams of your Figure 2. With what power of 10 should the numbers at the left-hand side of these six diagrams be multiplied to give X as defined in your equation (6)? Some calculations of my own suggest that in diagram a the numbers should be multiplied by  $10^{11}$ , while in diagram c (and perhaps

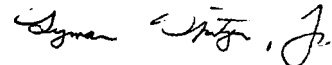
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2.

in all the others), a factor of  $10^{12}$  is required. Is this surmise correct?

Do you plan to continue this fundamental work? It would certainly be interesting to look at other declinations.

Very sincerely yours,



Lyman Spitzer, Jr.  
Director

LS:vm