ON MICROWAVE RECOMBINATION LINES FROM H I REGIONS

B. ZUCKERMAN*
University of Maryland, College Park, Md., U.S.A., and
University of California, Berkeley, Calif., U.S.A.

and

JOHN A. BALL
Center for Astrophysics, Harvard College Observatory and Smithsonian
Astrophysical Observatory, Cambridge, Mass., U.S.A.

Abstract. There has been considerable uncertainty in the nature of the regions from which carbon and narrow hydrogen lines have been observed. Specifically there are two different models. In model I the lines originate in low-density H I regions that are basically atomic, and stimulated emission enhances the line intensity by an order of magnitude. In model II the lines originate in the outer layers of very dense molecular regions and are due primarily to spontaneous emission. The first model is generally accepted and used by the astronomical community. However, we believe that the second is correct.

We observed recombination lines attributed to carbon at 21-, 30-, 36-, and 43-cm wavelengths toward IC 1795 (W3), Orion A, and NGC 2024; and a narrow hydrogen line toward NGC 2024.

A comparison of a considerable body of carbon recombination-line and radio molecular-line data indicates that these two types of lines are probably formed in dense contiguous regions – the carbon lines in a thin layer facing a hot star and the molecular lines in the rest of the cloud shielded from the stellar radiation by the carbon-emitting slab.

The high-frequency carbon lines toward Orion A are probably due to spontaneous rather than stimulated emission, which might not play an important role in any carbon-line emission region. In NGC 2024 the H I regions responsible for the observed hydrogen and carbon lines are probably dense ($n_H > 10^3$ cm^{-3}). Previous estimates of the fractional ionization of hydrogen may be inaccurate because different volumes of gas may be observed in the hydrogen and carbon recombination lines. Without further calculations and observations it is not possible to decide whether the narrow hydrogen line originates in a dense 'cloud' or in an ionization front.

We give a fuller account in the *Astrophysical Journal* **190** (1974), 35.

B. Zuckerman
University of Maryland Astronomy Program,
College Park, Md. 20742, U.S.A.

* Alfred P. Sloan Foundation Fellow.

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John A. Ball
Center for Astrophysics,
Harvard College Observatory and Smithsonian Astrophysical Observatory,
60 Garden Street,
Cambridge, Mass. 02138, U.S.A.

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