

There are many other cases of significant practical importance which can be brought within the purview of such studies, but those are not discussed here. As has already been pointed out in the literature, there is a need for studying experimentally both the electrical and mechanical relaxation effects on the same samples of crystals. The close analogy that exists between the normal vibrations on the one hand and relaxation modes on the other also enables group theoretical methods which have already been successfully applied in the former case being extended to the latter as well. There is scope for extending such studies to investigate

the influence which defects in crystal lattices are likely to exert on a variety of physical properties particularly in relation to crystal symmetry.

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3. Haven and Van Santer, *Nuovo Cimento, Supple-mento VII*, 1957, p. 605.
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MOLECULAR HYDROGEN IN INTERSTELLAR SPACE

EXTENSIVE radio observations of our galaxy have shown that there are vast regions containing neutral atomic hydrogen at an average density of 1 atom/cm.³ Also the 21-cm. scanning of interstellar space has given strong evidence that the hydrogen is distributed in dense "clouds" in which the density is about as much as 10 atoms/cm.³, and that these H I clouds fill roughly 10% of the interstellar space, their average kinetic temperature being about 100° K.

At this temperature hydrogen gas even at the low density of 10 atoms per cm.³ would be almost completely molecular if thermal equilibrium existed. However, the conditions in H I clouds are very far from thermal equilibrium, and a gas initially purely atomic will be converted very slowly into molecular form.

In two theoretical papers contributed to the *Astrophysical Journal*, R. J. Gould, E. E. Salpeter and T. Gold discuss the various plausible processes whereby molecular hydrogen may be formed in interstellar space. The most efficient mechanism for the formation of H₂ is the catalytic process of recombination reaction on the surface of the interstellar grains, first suggested by van de Hulst. Interstellar grains appear to have physical properties that make them efficient catalysts for the formation of molecular hydrogen. Gould and Salpeter show that this process of association on the surface of the interstellar grains has a characteristic time possibly as short as 10⁸ years, which is two orders of magnitude less than the age of the galaxy. Thus known physi-

cal processes can produce a high abundance of molecular hydrogen. However, at present, there is no easy way of detecting interstellar molecular hydrogen. Spectroscopic detection of interstellar H₂ is extremely difficult. The first bound excited electronic state of the molecule (11 ev.) gives absorption in the inaccessible ultra-violet. Being homopolar, the molecule has no permanent dipole moment, so that its pure vibration-rotation absorption is very weak. Moreover, the molecule has no fine or hyperfine structure splitting in the ground state, so that there can be no detection by radio emission analogous to that of the 21-cm. line of atomic hydrogen. Experiments in this direction, however, are underway which may prove successful. For example, The Princeton Observatory's spectroscope-carrying satellite to detect ultra-violet absorption lines; observation of near infra-red vibration-rotation radiation from H₂ near hot stars as suggested by Gould and Harwit.

If there is a high abundance of H₂ as is predicted by the present calculations of the authors, and also as has been suspected for nearly two decades, the H I clouds temperature is likely to be closer to 50° K.—since hydrogen molecule is an effective cooling agent—than to 100° K. as initially given by the 21-cm. investigators. In this connection it may be emphasized that the latest 21-cm. investigations by Radhakrishnan et al. actually do point to a lower temperature, and this may be taken as weak evidence for a high molecular abundance.—(*Astrophys. J.*, 1963, **138**, 391.)