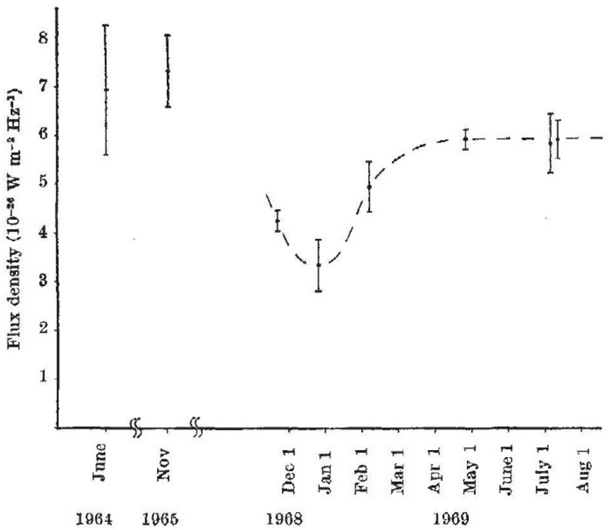

Fig. 1. Continuum flux density measurements of VRO 42 22 01 at 1,420 MHz.

Hz^{-1} (private communication from A. H. Bridle and D. G. Macdonell).

The percentage flux density change at 1,420 MHz shown in Fig. 1 is as large as the variations measured at higher frequencies by Andrew *et al.*, whereas in the case of other variable radio sources the amplitude of the variation at 1,420 MHz is considerably less than that found at frequencies above 5,000 MHz. Continued flux density measurements at several frequencies will show whether the variability of VRO 42 22 01 can be explained in terms of current theoretical models.

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J. F. R. Gower

Department of Physics,
University of British Columbia,
Vancouver 8, BC, Canada.

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On the Question of Interstellar Diamonds

The evidence to support the recent proposal[1] that interstellar extinction may be caused by small diamond crystals is open to substantial criticism. Wickramasinghe[2] has shown that the optical properties of diamond do not readily provide an explanation of the observed interstellar curve. Similar calculations made by us support and extend Wickramasinghe's results. It may be possible to modify the form of the size distribution until the interstellar extinction curve is reproduced as Greenberg and Shah[3] have done for "dirty ice" grains. For diamond, however, considerable variation in the slope occurs in the infrared and it is not obvious that it will be possible simultaneously to fit the infrared, visible and ultraviolet regions.

More serious objections exist regarding the suggestion by Saslaw and Gaustad that diamonds may form and grow rapidly in conditions appropriate to cool stellar atmospheres. It is well known that graphite is the stable carbon phase below about 10^4 kbar. This occurs because of the lower free energy of graphite. The spontaneous nucleation rate in the vapour depends critically on the free energy, and graphite will also preferentially nucleate, as is shown by the very extensive work on carbon condensation in flames. There is no reported case of diamond formation in flames although much effort has been devoted to the study of soot formation (Combustion Symposia 1–11, Combustion Society). Flame temperatures are comparable with those in cool stellar atmospheres although flame pressures are about one atmosphere. A wide range of carbon to hydrogen ratios have been used and the carbon source has varied from methane to aromatic molecules.

Physically, the difficulty is that in order to nucleate diamonds, carbon rings with a puckered structure characteristic of the diamond lattice must be formed. At low pressures all carbon rings are planar and only graphite with its flat layers can form. Thermodynamically unstable phases sometimes form instead of the stable phase. In the case of carbon, however, it is graphite that forms in the stability region of diamond[4], never the reverse. Homogeneous condensation of diamond in cool stars or interstellar space can be ruled out.

Another possibility is the growth of diamonds on seed nuclei. Growth of an unstable phase on a surface having the crystal structure of the unstable phase is well known. Experiments[5] at 1,000° C using diamond as a seed show the formation of new diamond layers. In all cases, however, the surface becomes covered with graphite. In order to continue the experiment the graphite must be removed. Although hydrogen reacts faster with graphite than diamond, a high hydrogen pressure (10–50 atmospheres) was used. Because the carbon source in the experiment was a gas containing a methyl group (CH_3), free hydrogen was present but apparently at too low a pressure to remove the graphite.

Finally, we note that in stellar atmospheres the seed crystal could not be diamond. Saslaw and Gaustad suggested silicon carbide, SiC, which has a crystal structure similar to diamond. But although diamond has been grown on silicon, no diamond has so far been found when SiC is used for the substrate[4].

There does not seem to be any theoretical or experimental evidence at present that supports the hypothesis of diamond growth under stellar or interstellar conditions. As no laboratory research has been done with the astrophysical problem in mind, not all relevant conditions have been examined. A more extensive study of silicon carbide as a seed nucleus and the dependence of graphite removal on atomic and molecular hydrogen pressure would be of interest.

One of us (K. S. K. S.) is an NAS–NRC resident postdoctoral research associate.

Bertram Donn
K. S. Krishna Swamy

NASA–Goddard Space Flight Center,
Greenbelt,
Maryland 20771.

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