known relative abundances of C, O, Mg, Si to hydrogen further support this view.

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Reply from Duley

IN view of the improved fit to the interstellar extinction curve one must now ask whether or not this calculation provides any additional evidence for the presence of either silicates, iron or graphite in the interstellar medium. It is my contention that no additional evidence has been presented.

The very nature of the extinction curve, which apart from the hump at $4.6 \mu\text{m}^{-1}$ is featureless, precludes any unique identification of the scattering particles. This point has often been raised previously (for example, by Deirmendjian¹) but apparently has been ignored in the present context. Increasing the number of variables in the calculation by using three types of particle, three sets of radii, and so on, greatly enhances the possibility of fitting the curve but at the same time weakens any conclusions that could be drawn from such a fit.

If the calculations of Wickramasinghe and Nandy are taken as conclusive we are being asked to accept that not only are iron, graphite and "silicates" present in interstellar space but that (i) they are all present in the form of spherical particles, (ii) the size distribution for these particles is the same as that for atmospheric aerosols, (iii) the average radius of these particles is $0.02 \mu\text{m}$ for iron, $0.06 \mu\text{m}$ for graphite and $0.15 \mu\text{m}$ for silicates, (iv) the relative abundances of these species have been determined, (v) the refractive indices of the bulk materials apply to particles of radius $0.02\text{--}0.15 \mu\text{m}$, and finally, that (vi) nothing else is present in comparable quantity. Surely this much information cannot be extracted from a single measurement of Q_{ext} against λ . This situation would not be improved significantly were a fit also to be obtained with polarization and albedo data. Wickramasinghe and Nandy have succeeded in finding one solution to the problem when a large and perhaps infinite number of solutions exist.

Much has been made of the need for graphite to produce a hump in the extinction curve at $4.6 \mu\text{m}^{-1}$. Graphite is not the only material known that has a strong absorption band in this region. For example, many solid hydrocarbons and even silicates absorb in the $2200 \text{ \AA}$ region. By a proper choice of particle size, a fit to the $4.6 \mu\text{m}^{-1}$ feature can easily be obtained² for grains composed of solid hydrocarbons.

I must also disagree with the authors when they state that the present calculation provides "direct spectroscopic evidence . . . for silicate particles in space". The fact that the infrared extinction curve passes through the error bars on three experi-

mental data points in the $8\text{--}13 \mu\text{m}$ region offers little information on the nature of the absorber. One could just as easily pass a straight line through the same points. Organic chemists find it necessary to consult large files of infrared spectra in order to identify a species whose spectrum they know exactly. Here an identification is thought to be justified on the basis of a match within error bars at three wavelengths. Surely more experimental data in the $8\text{--}13 \mu\text{m}$ region is needed before such a conclusion can be verified.

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Evidence of Quasi-periodic Movements in the Solar Chromosphere and Corona

PRESENT ideas on the origin of the solar corona and the means of energy supply to the solar wind suggest that the various waves in the solar atmosphere, excited by convective motions in the sub-photospheric layers, are responsible for the mechanisms which maintain the chromosphere and for coronal heating. Variations of density, temperature and magnetic field with height can be related to the transformations of one type of wave into another. There can be no doubt that these waves have an important role in the physics of the solar atmosphere, but so far only tentative studies have been undertaken. We believe that the study of these waves is clearly relevant to the physics and geophysics of the interplanetary medium by virtue of the possible modulation of the X-ray, ultraviolet and radio emission from the Sun as well as the solar corpuscular fluxes.

Optical observations of the wave motions in the solar atmosphere have been made chiefly in the lower chromosphere¹ and there is some doubt about whether it is possible with these methods to get information about similar motions in the upper atmosphere and corona. Solar radio emissions may provide valuable data on the wave processes in the upper chromosphere and corona. The influence of these motions in the chromosphere on the solar radio emission has not been observed, however, and this supports our view that if the

Fig. 1 The correlation functions for signal fluctuations from the Sun. a, April 13, 1967 (1100–1251); b, April 14, 1967 (1150–1401).