MR. GILLESPIE's recent communication[1] directs attention to the potential hazard created by the possibility of ionizing radiation attracting a lightning strike during a thunderstorm.

This hazard, if real, is a very grave one, and his letter is very timely, particularly in view of the increasing number of installations of kilocurie cobalt sources in radiotherapy departments. However, the figure he quotes of 0·00006 mr./h does not seem correct, because the natural background of radiation at ground-level, arising partly from cosmic radiation and partly from radioactivity mainly in building materials, gives rise to a radiation-level of about 0·012 mr./h.

It is obviously important for those who are responsible for the design of installations where large amounts of ionizing radiation are given out to know the correct figure.

N. W. RAMSEY

Charing Cross Hospital,
London, W.C.2.

[1] Gillespie, P. J., *Nature*, 208, 577 (1965).

PROF. ROBERTS's interesting comments on my communication regarding ionizing radiation and lightning substantiate my personal opinion that these devices are probably ineffective; this was one of the possibilities I mentioned originally.

However, it is of interest to note two statements made in sales literature issued by the manufacturers: (i) Their research work has shown that lightning will be effectively attracted if the atmospheric conductivity is doubled. (ii) The positive ions produced by the radiation will be attracted towards the negative cloud base, and in the strong electric field, such as exists immediately preceding or during a discharge, will initiate chain reactions which, by collision, increase the degree of ionization. This suggestion that an 'avalanche' ionization process occurs would, if well founded, answer the criticism that the very low dose-rates and therefore very low ionization would not be effective, as in these circumstances the ion density would be higher than the radiation alone would produce.

In view of the fact that it appears many thousands of these sources have been installed in nineteen different countries over the past eight years, and that many particularly vulnerable buildings, for example, chemical plants, explosive magazines, oil refineries, etc., have probably been fitted with them (at high cost—it may cost more than £2,000 to protect a large building), it seems very desirable to establish conclusively whether or not they are effective.

Regarding Prof. Roberts's statement that he is unaware of any legislation concerning these devices, the Order to which I referred was Statutory Instrument No. 1835, "The Radioactive Substances (Attachments to Lightning Conductors) Exemption Order, 1963", which came into force on December 1, 1963, under Section 2 (6) and (7) of the 1960 Radioactive Substances Act. There is a very similar statutory order applicable to Northern Ireland.

Mr. Ramsey raises an extremely interesting point; that even if a dose-rate of 6×10^{-5} mr./h has no effect on the path chosen by a lightning strike (and this point has still to be conclusively established), possibly some higher radiation dose-rate would.

Arguing by extremes, like Prof. Roberts, but in the other direction, it is generally accepted that intense beams of ionizing radiation can produce a highly conductive path through air, for example, many industries use antistatic devices consisting of radioactive sources which will effectively earth moving machine parts through the conductive path in air produced by the radiation beam. So, if one accepts the fact that ionizing radiation can be used to induce an electrostatic discharge, the pertinent question is, at what dose-rate and under what conditions could this be effective in relation to lightning?

P. J. GILLESPIE

Northern Ireland Radiotherapy Centre,
Montgomery House,
Purdysburn, Belfast.

Velocity of Ultrasonic Waves in Single Crystals of Calcium Fluoride

THE elastic constants of crystals are commonly determined by measuring the velocities of propagation of acoustic waves in different principal crystal directions and applying well-known formulae[1]. For crystals of high perfection it has generally been reported that the measured velocity of sound of a given substance is substantially independent of impurity concentration and is a slowly varying function of temperature. There have been relatively few investigations of the dependence of acoustic velocity on impurity density due to the fact that, until recent years, the preparation of highly doped single crystals of high perfection was virtually impossible. We have investigated ultrasonic propagation in a number of calcium fluoride monocrystals grown in the <111> direction by the Czochralski technique. Some of the crystals were of high purity and others were doped with up to 2 per cent significant impurity for experiments on laser action. They were all of comparable perfection, with measured dislocation densities lying in the range 10^4–10^5 cm^{-2}. Samples for measurement were cylinders with opposite ends cleaved and finely polished to plane-parallelism.

The velocities of both longitudinal (v_L) and shear (v_S) ultrasonic waves in the crystals were determined for propagation in the <111> direction and care was taken to determine these quantities to an accuracy of better than 0·5 per cent by means of the pulse-echo technique. Quartz transducers were used and measurements were made by conventional methods. The time markers were calibrated by means of a nickel delay line. Some representative results of room-temperature measurements made with 10 Mc/s input pulses are given in Table 1.

Table 1

Crystal	Impurity	Colour	v_L (km sec^{-1})	v_S (km sec^{-1})
1	Pure	Colourless	6·50	3·98
2	Uranium	Dark pink	6·53	4·06
3	Uranium	Brown	6·67	4·09
4	Samarium	Green	6·44	4·02
5	Neodymium	Light green	6·45	4·03

The values of velocity are taken from a series of measurements on specimens of uniform colour cut from each crystal and the accuracy is believed to be better than 0·5 per cent so that the last figure in each case is significant. The values for pure material closely agree with the results quoted by Gerlich[2]. It seems clear that for crystals of calcium fluoride doped to about 1 per cent with the impurities mentioned in Table 1 the velocities of ultrasonic waves differ from the values for pure material, being greater in some cases and less in others, even though the samples are otherwise of comparable crystal perfection.

We thank the British Council for the award of a travelling scholarship to one of us (Yu. G. S.), G. W. Green of the Royal Radar Establishment for the supply of single crystals and Mr. J. Blitz for discussions about the measurements.

C. A. HOGARTH
YU. G. SMIRNOV*

Department of Physics,
Brunel College,
London, W.3.

* Permanent address: Institute of Aviation Instrument Manufacture, Leningrad, U.S.S.R.

[1] Mason, W. P., *Physical Acoustics and the Properties of Solids* (New York, Van Nostrand, 1958).
[2] Gerlich, D., *Phys. Rev.*, 136 (5A), 1366 (1964).