We have therefore examined a number of samples from sources which were either producing commercial quantities of pyrochlore concentrate already, or which might become of commercial interest in the future as a source of niobium.

The niobium in the samples was determined by an adaptation of the method described by Pickup[4], in which the sample materials were decomposed by digestion with hydrofluoric acid, the precipitated fluorides removed, and the niobium solutions evaporated with sulphuric acid. The determinations were completed spectrophotometrically, using the colour given by niobium with hydrogen peroxide in a sulphuric–phosphoric acid solution.

The tantalum determination, based on the procedure of Atkins and Smales[5], involved measuring the activity of the separated tantalum after irradiation of the sample materials in *Bepo* reactor for 12 days at a neutron flux of 2×10^{12} n/cm² sec. Following irradiation, an inactive tantalum solution was added as carrier, and decomposition effected by evaporation with hydrofluoric acid. The tantalum was precipitated from a sulphuric–tartaric acid solution with tannin at *p*H 2·3, and converted to oxide. This was dissolved in a hydrofluoric–nitric acid mixture, the tantalum present extracted into methylisobutylketone, back-extracted into hydrogen peroxide solution and reprecipitated with tannin at *p*H 2·3. The tannate was ignited to oxide, weighed and the activity of the tantalum-182 isotope measured.

The results are given in Table 1

Table 1

Sample	Ta (p.p.m.)	Nb (%)	Nb/Ta
Pyrochlore concentrate, Mrima, Kenya	565	28·6	506
Pyrochlore soil, Mrima, Kenya	61	1·27	208
Pyrochlore, picked crystals, Sukulu, Uganda	17,060	46·6	27
Pyrochlore, Nkombwa, Rhodesia	405	51·7	1,277
Pyrochlore, soil, Araxa, Brazil	232	3·29	142
Barium pyrochlore, Araxa, Brazil	559	38·7	692
Pyrochlore, Chilwa, Nyasaland	73	42·4	5,808
Pyrochlore crystals, Leushe, Kivu, Congo	446	48·2	1,081
Pyrochlore, Panda Hill, Tanganyika	6,300	40·5	64
Pyrochlore crystals, Lokupoi, Uganda	444	46·3	1,043
Pyrochlore concentrate "A", Oka, Quebec, Canada	4,170	35·9	86
Pyrochlore concentrate "B", Oka, Quebec, Canada	1,563	40·5	259
Pyrochlore concentrate "C", Oka, Quebec, Canada	1,453	41·5	286
Pyrochlore concentrate, Busumbu, Uganda	31,690	29·3	9·2
Pyrochlore concentrate, Søve, Norway	4,210	38·8	92

On the face of it, the interest might be restricted to pyrochlores with niobium/tantalum ratios of around 700 : 1 (2,000 : 1 in the United States), corresponding to the desirable concentration of 0·15 per cent tantalum in the metal. However, this need not be the case, in that in processing the ore, from concentrate to metal, some preferential depletion of tantalum occurs, even without the hexone separation step. Thus, niobium/tantalum ratios as low as 500 : 1 may be satisfactory for reactor grade metal and also for alloy production[6]. Specifications for other applications of pure niobium metal (for example, niobium-base super-conducting alloys) are less stringent concerning tantalum concentration in the metal. It is expected that for such applications most of the pyrochlores listed in Table 1 would be suitable without the hexone extraction step. Thus, the availability of pyrochlores as a source of niobium metal can be expected to make an important contribution to an eventual reduction in the cost of this element for industrial applications.

J. M. Bakes
P. G. Jeffery
J. Sandor

Warren Spring Laboratory,
Stevenage, Herts.

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PHYSICS

Gravitational Collapse

Hoyle and Narlikar[1] have recently considered the gravitational contraction of large spherically symmetric masses. They claim that according to the field equations of general relativity a sufficiently large mass must collapse to a space–time singularity, provided that the equation of state of the matter is realistic. Much of their argument is based on the alleged absence of suitable static spherically symmetric interior solutions.

I wish to point out that a relativistic solution exists for a static pressure-free sphere of arbitrary size and mass provided that the matter carries an appropriate electric charge. This is the counterpart of the classical solution in which gravitational attraction and electric repulsion just balance. The metric outside the sphere can be put in the form:

$$ds^2 = -\left(1 + \frac{m}{r}\right)^2 (dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\varphi^2) + \left(1 + \frac{m}{r}\right)^{-2} dt^2, \quad (1)$$

and the electrostatic potential is $e/(r + m)$, where $|e| = m$ in relativistic units, or $|e| = m\sqrt{G}$ in dimensional units, G being the gravitational constant. It is known[2] that there exist interior solutions which: (*a*) satisfy the correct boundary conditions at the surface; (*b*) are regular and have positive mass density throughout the interior. The internal electric charge density is everywhere proportional to the mass density, which is arbitrary. It will be noted that the metric (1) has no Schwarzschild singularity.

The total electric charge of the sphere is fairly small compared with the mass: a sphere of neutral hydrogen which had lost a fraction 10^{-18} of its electrons could satisfy the conditions.

There also exist static solutions for a sphere carrying no total charge but inside which there is a separation of positive and negative charge. In this case the exterior field is a Schwarzschild one, but the interior would carry, say, an excess of positive charge near the centre balanced by an envelope of negative charge. Although solutions satisfying the boundary conditions exist[2], it is not known whether they permit an isotropic positive pressure which may be a desirable feature from the physical point of view.

These considerations suggest that charged interior solutions may be relevant to the problem of gravitational collapse.

W. B. Bonnor

Queen Elizabeth College,
University of London,
London, W.8.

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Non-thermal Biological Effects of Laser Beams

Investigating the effects of pulsed and continuously emitting lasers, we were able theoretically and experimentally to establish that non-thermal effects exist which have to be considered biologically more important than the thermal effects, such as the discrete coagulation of tissue which is therapeutically used, for example, in eye surgery.

We calculated that the laser field has an important electrical vector which has to be considered responsible for causing biological effects of the following classification: (*a*) thermal; (*b*) specific-thermal; (*c*) specific-electric; (*d*) chemical; (*e*) kinetic.

If the output of a laser is focused optically on an absorbing area, it is possible to produce a very high