MATTERS ARISING

Rotating lunar globules

SEVERAL theories have been proposed for the origin of the shapes of lunar dumbbell and ellipsoidal glass globules. The rotational theory[1] assumes that they solidify while rotating in free fall above the lunar surface, the rotation giving the elongation in form. A second theory imagines solidification of a jet of liquid again above the lunar surface and at some time during the break-up of the jet[2–4]. More recently Chernyak and Nussinov[5] have proposed that the shapes are caused by the sudden freezing of a vibrating droplet. They also cite arguments against a rotational origin. However, there is now much evidence favouring the rotational hypothesis.

Chernyak and Nussinov propose that "the drops vibrate" and "because of the exponential dependence of viscosity on temperature the particle solidifies and memorises its shape". Such a proposal is completely untenable as a glass drop cannot pass from an essentially liquid to solid state in a time that is short compared with its vibrational period. The period of vibration of a droplet of diameter 100 μm is about 10^{-4} s. Even assuming it radiates as a perfect black body the drop in temperature of such a globule during its vibrational period is between 0.1 and 0.01 K. Although the viscosity of glasses varies very rapidly with temperature (three orders of magnitude for a temperature change of 100 K) it is impossible that there can be any appreciable change in viscosity during a single period of oscillation, let alone during the small fraction of the period required by the vibrational hypothesis. Similar numerical analyses for larger or small droplets yield essentially the same conclusion because the ratio of the vibrational period to the time taken to cool through a given temperature interval varies only slowly with particle size[1] (in fact, as the square root of its linear dimensions).

Arguments by Chernyak and Nussinov[5] against the rotation hypothesis depend on the instability of dumbbell shapes and the effect of Coriolis forces which would bring about S or crescent shaped particles. Although several curved smooth glassy particles have been found in lunar soil and it is reasonable to use a Coriolis force mechanism to explain their shape, if the initial temperature of a particle is sufficiently high, the cooling time is long enough for viscous forces to damp out all appreciable internal motion. While still liquid the globule will thus eventually rotate as a rigid body[1] and Coriolis forces are then not involved.

Chernyak and Nussinov's argument that dumbbell shapes are unstable is also not substantial. Imagine a small liquid sphere in an inertial frame held together only by surface tension forces. Suppose a small external couple acting for a limited time causes the globule to be brought into rotation. After the couple has been removed the globule will attain an aspherical rotating form in which any internal motions will gradually be eliminated by viscous damping. The form of the globule is then stable yet not spherical. The process may be repeated so that more and more angular momentum will be slowly given to the globule. Eventually the system will disintegrate but it is unclear whether before this disintegration occurs stable forms may exist with re-entrant shaped cross-sections—dumbbells.

There are many other reasons for preferring the rotational hypothesis. (1) The photographed shapes of lunar dumbbells[6] are not the same as those formed by jet break-up[7]. The latter have low curvature at their extremities. (2) The curvature of the surfaces of lunar dumbbells has been shown to agree well with that predicted from rotational theory[6]. (3) The break-up of a jet is a transitory phenomenon: a rotating dumbbell is a stable form so that the latter would be expected to occur more frequently. (4) There is no evidence that regular cylindrical liquid jets can be formed by volcanic activity or hypervelocity impacts. Such a jet is required by the jet break-up hypothesis[2,3]. Some evidence does exist for jet formation following meteorite impact[8] but here 'jet' simply implies a group of particles moving with high speed in approximately the same direction. The confusion is semantic. (5) The angular momentum of dumbbells and prolate globules is well accounted for by local inhomogeneities in surface rock at the impact site. (6) Voids both in the dumbbells and the oblate spheroids tend to be found close to the rotational axis, whereas darker and more dense particles are found closer to the extremities[9]. Generally more migration has occurred in the case of the larger particles and voids; and this is precisely what would be expected from Stokes' law and the rotational hypothesis. (7) The densities of the dumbbell extremities are found to be higher than the central portions, a result predicted by the rotational hypothesis (T. Gold, personal communication).

The rotation hypothesis supplies a means of determining the maximum temperature of droplets during their formation. It also favours a lava fountain origin for many of the green and orange lunar droplets as no dumbbell-shaped globules have been reported among these samples[10]. It is also relevant to the question raised by Butler[11] concerning whether these droplets were splashed from molten lava by impact.

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Dihydroergocryptine binding and α-adrenoreceptors in smooth muscle

THE recent letter by Kunos *et al.*[1] in which they "dissociate phentolamine-suppressible ^{3}H-dihydroergocryptine (^{3}H-DHEC) binding and α-receptors" in rabbit myometrium disagrees with previous reports[2,3] and contains several puzzling features.

First, the authors assume that the concentrations of phenoxybenzamine (POB) inhibiting noradrenaline-stimulated contractility should coincide with concentrations of POB that compete for ^{3}H-DHEC binding sites. As the number of steps between receptor binding and contractility is unknown, one ought not necessarily expect such different experimental approaches to yield similar results[4,5]. Moreover, it is probably unreasonable to ascribe the effects of a partially irreversible α-adrenergic blocker (POB) on contractility solely to blockade of α-adrenergic receptors, because POB also inhibits response to serotonin, histamine and acetylcholine[6]. Second, the authors suggest that two classes of ^{3}H-DHEC binding site (K_d values 1.5 and 5.5 nM) exist in their preparations. The data used to determine those K_d values were apparently obtained from pooled determinations of different uterine preparations. In view of the likely heterogeneity between particulates of crude myometrial homogenates subjected to

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