Are the Libration Clouds Real?

It is disconcerting that the existence of dust cloud satellites at the L_4 and L_5 libration points in the Earth–Moon system, first reported by Kordylewski[1], is so widely accepted[2–6], in view of negative radar results[3], and optical results[7–11], some of which report no clouds even to a limit twenty to thirty times fainter than the brightness claimed by Kordylewski. Other discussions[12,13] have also argued against the existence of libration clouds. While there undoubtedly exist patches of brightness in the night sky, their connexion with the libration points is unproven.

There are also serious theoretical difficulties in understanding how any cloud of particles could either collect there or maintain an orbit against the disruptive perturbations of solar gravity, radiation pressure and solar wind. Although stable orbits at these points have been found numerically[14], the initial conditions are so restrictive that it is most unlikely that enough particles could be found to produce a cloud. Schutz has pointed out in a personal communication that in any case the delicate stability of the orbit could well be destroyed by perturbations due to lunar eccentricity.

Further, because the visual observations are at the limit of detectability for the human eye, there can be honest differences of opinion over sightings. In fact, Backhouse (an independent discoverer of the gegenschein) remarked[15], "It is a question whether one may not say there are streaks and patches of Milky Way all over the sky, for I do not think there is a uniformity of light in any part at a reasonable altitude". There is also the possibility that irregularities in the brightness of the Earth's airglow layer can occasionally give rise to a false libration cloud report. For reasons like these the NASA visual observers[16] were careful to report observing only "luminosities" and did not claim to have observed libration clouds.

But the existence of observable concentrations of dust in interplanetary space should not be ruled out. Meteor streams and comet tails are two sources of material. The Smithsonian Astrophysical Observatory[17] has initiated a programme of photographing points of tangency in the orbits of meteor streams, while a correlation has been found[18] between the orbits of low inclination short period comets and the interplanetary dust particle events reported by both Soviet and American satellite observers[19,20].

To demonstrate that observable concentrations of interplanetary dust might exist, we have considered the results from five American and Soviet satellites which carried dust counting experiments and which observed many periods of sustained increases in the counting rate[20]. The fine structure of the Vanguard III event is about 10^4 s with an impact rate of about 10^{-5} particles cm^{-2} s^{-1}. If, for simplicity, we assume that this is due to the Earth and satellite passing through a spherical cloud with a uniform number density of particles, then the cloud has a column density N of 10^{-1} particles cm^{-2}. The brightness of such a cloud is[21]

$$B = INAf(\theta) \qquad (1)$$

where I is the solar intensity ($1 \cdot 4 \times 10^6$ ergs cm^{-2} s^{-1} at the Earth's orbit) and A is the scattering cross-section of the particles. The fraction of light per steradian scattered in the direction θ is $f(\theta)$ and is about 10^{-2} for an albedo of 0·1 and isotropic scattering. For dust of diameter 10 μm the brightness B is 10^{-3} ergs cm^{-2} s^{-1} sr^{-1}, which is half as bright as the gegenschein, and therefore well above the visual threshold of detection.

Such clouds near the Earth could explain the many reported fluctuations in brightness and shape of the zodiacal light and gegenschein[22], and further from the Earth might account for the clouds reported by Kordylewski and others. The time scale for interplanetary dust particle events is of the order of many hours, which is similar to the time scale of these phenomena.

If the dust is distributed along an eccentric orbit with sufficiently large aphelion, the cloud would be longer in the direction radial to the Sun. Because the satellite measurement is more nearly of an azimuthal dimension, the actual brightness would be greater than estimated here. On the other hand, the gravitational field of the Earth concentrates any cloud passing near it[23], so that as the cloud leaves the vicinity of the Earth it expands and decreases in brightness. Finally, the particle size is uncertain and the spatial density of particles varies. For all these reasons such clouds would range widely in brightness and much of this range is observable.

There are many possible explanations of curious patches of light seen in the night sky, and we believe that Earth–Moon libration clouds are very unlikely.

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Tungsten Radioisotopes in the Atmosphere near Pisa, Italy

Our nuclear centre carries out a complete programme of environmental radioactivity measurements on air, fall-out, surface water and so on. We report high values of the delayed beta activity on paper filters collected on a daily basis at airborne radioactivity collection stations on December 18–20, 1968. We began by looking for possible accompanying alpha activity, which was not found, but the gamma spectrum had a surprising shape.

The bulk of counts was not due to the energies of fission products or of other usual fall-out components (^{144}Ce–^{144}Pr, ^{7}Be, ^{140}Ba–^{140}La, ^{103}Rh–^{103}Ru, ^{106}Rh–^{106}Ru, ^{137}Cs, ^{95}Zr–^{95}Nb, ^{54}Mn), but was primarily concentrated in the low energy region where it is well known that the interpretation of gamma spectra requires a very accurate energy calibration. After a careful examination we concluded that the peak energy was 58 ± 1 keV. Fig. 1 shows the peak (background subtracted) which was chiefly responsible for the gamma counts. A decay measurement of the gamma activity based on peak height or peak area showed a half-life of 140 ± 10 days. On the other hand,