predominant insertion opposite apurinic sites in single-stranded ΦX174 DNA and Kunkel (University of North Carolina) obtained a similar result with heat-treated single-stranded M13 mp2 DNA. This is consistent with *in vitro* observations on DNA polymerase I by Loeb and by Strauss (University of Chicago). In terms of selective advantage during evolution this would seem sensible as the lesions most likely to be encountered by a DNA replication fork in significant numbers are sunlight-induced photoproducts involving adjacent thymines. Preferential insertion of deoxyadenosine in such a circumstance would result in conservation of the genetic information rather than mutation.

Although untargeted mutations were frequently found in infections of UV-irradiated bacteria by bacteriophage they were presumed to be less important in bacteria themselves because of the effectiveness of the bacterial mismatch-correction system. This system is able to distinguish a newly replicated DNA strand from the parental strand by the former's paucity of methylated adenines and acts by correcting replication errors in the newly synthesized strand against the 'correct' sequence in the parental strand (Meselson, Harvard University). The same phenomenon has now been shown to operate in cell-free extracts of *E.coli* (Lu, Duke University). The *in vitro* activity is dependent on the state of the *dam* methylation of the DNA and is deficient in extracts of the mutator strains *mut-H*, *mutL* and *mutS*. The correction process involves a repair-synthesis event of considerable length (up to 1,000 nucleotides) which probably stretches between the mismatch site and the nearest *dam* methylation site. Both these sites (relatively remote from one another) have to be present for the repair synthesis to occur, which raises intriguing possibilities for the mechanism of action. □

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Celestial mechanics

Acceleration on Lageos spacecraft

from David E. Smith

SINCE the launch of the Lageos spacecraft in May 1976 into a near-circular orbit at 6,000 km altitude, the spacecraft orbit has been decaying at an average rate of about 1 mm per day. This decay causes the satellite to accelerate in its orbit at a rate of about 3×10^{-12} m s^{-2}, which is one to two orders of magnitude larger than was expected. The cause of the acceleration (orbit decay) is unknown but calculations and theoretical studies of the changes in the spacecraft orbit suggest that charged-particle drag and Earth albedo radiation pressure (sunlight reflected from the Earth back onto the spacecraft) are the most likely explanations. Recently, the orbital decay seems to have ceased and even reversed, at least temporarily, so that the orbit may be beginning to increase again in size. If this is the case, charged particle drag cannot be the sole explanation and Earth albedo becomes a very probable second cause.

The Lageos spacecraft is a sphere 60 cm in diameter carrying 426 laser corner reflectors on its surface. The precision-built spacecraft was designed to be a near-perfect target for ground-based laser-tracking systems that could measure the spacecraft's distance (range) to better than a centimetre. The measurements were to be used to determine precisely the relative positions of the laser-tracking stations for estimating crustal movements, such as tectonic plate motion, and the rotation of the Earth on its axis.

Because of its design, high altitude and very accurate tracking, Lageos has the most precisely known orbit of any artificial satellite. Within weeks of its launch it became clear that the spacecraft was accelerating in a manner consistent with drag (neutral or charged particles) but at a much higher rate than expected[1]. Attempts to explain this fact[2] were initially directed towards the possible existence of helium at the satellite's altitude of 6,000 km but ran into the difficulty of requiring very large exospheric temperatures. Neutral hydrogen was also ruled out as the primary cause of the drag[2,3] and attention became focused on the effect of charged particles. As the spacecraft moves through the atmosphere it becomes charged through collisions with charged particles and interacts electromagnetically with particles at a distance, thereby losing energy. Although we do not know the charge on the spacecraft it seemed that charged-particle drag could account for the observation[3-5].

Several years of laser tracking of Lageos have shown systematic variations in the accelerations about the mean of around 100 per cent and with several different periods. The largest-amplitude period is about 285 days, half the time the orbit takes to precess in space with respect to the Sun. Although the variations in the acceleration are significant, none has been successfully correlated with standard atmospheric indices, such as 10.7-cm solar radiation or planetary indices reflecting particle fluxes in the atmosphere. The existence of a strong 285-day period in the acceleration however, is a clear indication that the effect, at least in part, is related to the geometry of the orbit with respect to the Sun and therefore of solar origin.

Recently, Anselmo *et al.*[6] have investigated the effect of Earth albedo on Lageos and, in particular, variations between the Northern and Southern Hemispheres. In their model, the force of the albedo as the satellite crosses the terminator of the Earth's shadow in the Northern Hemisphere is not balanced by the force of the albedo as the satellite crosses the terminator in the Southern Hemisphere because of the asymmetry of the albedo between the two hemispheres. When it is winter in the Northern Hemisphere, it is summer in the Southern Hemisphere. Moreover, the distribution of oceans and continents is different in each hemisphere. Anselmo *et al.*[6] show that the asymmetry in the reflective properties of the Earth between the Northern and Southern Hemispheres can produce a variable acceleration of the Lageos satellite very similar to that observed. Over several years however, this effect averages to zero and therefore cannot explain the basic acceleration. Nonetheless, considering the simplicity of the model it seems likely that the north–south asymmetric albedo is the cause of the variations in the acceleration that are seen on Lageos. Further, the model predicts several other periodic components that are seen in the acceleration data.

J. Morgan[7] has further suggested that asymmetries in the Earth's albedo in local time could cause the observed constant component of the acceleration of Lageos. In his model, the albedo of the Earth at dawn is different from the albedo at dusk, thus causing an acceleration (or deceleration) of the spacecraft. If the asymmetry in albedo with local solar time is preserved over extended periods of time, as the model suggests, then it could, in principle, provide the constant acceleration that is observed. Morgan's model has not yet undergone the testing required to establish the magnitude of the local time asymmetry that would be needed to sustain the acceleration.

Recent tracking data have suggested that the satellite is no longer accelerating but rather decelerating, causing the satellite orbit, at least temporarily, to stop decaying and expand. Verification of this change is extremely important because, if true, charge drag cannot be the only cause of the acceleration and an additional force, such as albedo, must be introduced. A temporary change in the albedo such that the acceleration becomes a deceleration is a much more acceptable explanation since the albedo is closely related to the vagaries of clouds and the weather and is known to vary geographically and seasonally. □

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