

## Satellites in decay

David W. Hughes

**A Tapestry of Orbits.** By Desmond King-Hele. Cambridge University Press: 1992. Pp. 244. £35, \$54.95.

BEING in the right place at the right time is of considerable importance when it comes to having a successful scientific career. Desmond King-Hele managed all three. The place was the Royal Aircraft Establishment (RAE) at Farnborough, England, the heart of British aerospace and guided-weapons research. He started work there in the early 1950s immediately after completing a mathematics degree at the University of Cambridge; and he stayed there until he retired in 1988.

Among his early tasks was a design study of the Skylark rocket and the British reconnaissance satellite. The latter work led to the investigation of the effects of both air drag and the non-symmetry of the Earth's gravitational field on the orbits and return paths of low-altitude satellites.

The right time was the dawn of the space age. The launch of Sputnik 1 on 4 October 1957 saw scientists such as King-Hele swept out of their academic 'ivory tower' into the maelstrom of real-life engineering. Theoretically, he had shown how the addition of only a small upper-stage could convert a ballistic rocket into a satellite launcher. Fortunately, the upper-stages of the Soviet Union's rockets were huge: Sputnik 1's was 20 metres long and Sputnik 2's measured 31.8 by 2.95 metres. The launch system was such that both upper-stages stayed in orbit after releasing their satellites and reflected sufficient sunlight that they appeared brighter than the Pole Star in the night sky. People in their thousands came out to watch them as they crossed the sky every hour-and-a-half. They were so bright that their paths could be easily measured. King-Hele's theories could be verified and it soon became clear that they were correct and that the orbits were decaying quickly. The orbital period decreased by about 2.3 seconds per day, indicating that the atmospheric density near perigee (250 kilometres above the Earth's surface) was about eight times what was expected.

If the launch had been a year earlier, King-Hele's theories would not have been ready. If the first Sputnik had appeared a year later he would not have had a 'flying start'. Also, a new digital computer (called Pegasus) had just been installed at RAE. This enabled the orbit

and ephemeris to be calculated in a few days as opposed to a few months. And coupled with these advantages was the unintentional assistance of the then Astronomer Royal. Richard Wooley did not want the Royal Greenwich Observatory to have anything to do with space research and he insisted that all satellite observations were sent to RAE as quickly as possible.

In *A Tapestry of Orbits*, King-Hele skilfully entwines a thorough, well illustrated and well referenced review of his scientific speciality with revealing snippets of autobiography. The mixture works very well. We read of how discoveries came thick and fast. Not only was the density of the upper atmosphere found to be greater than extrapolations indicated, but it also seemed to vary unpredictably from day to day, between day and night and as a function of the phase of the solar activity cycle. It was found to be windy up there, the upper atmosphere rotating some 25 per cent faster than the Earth's surface. Also the orbits of the satellite were very sensitive to small changes in the gravitational field. A 40 metre deformation of the Earth's surface leads (depending on orbital inclination) to a 5 to 10 kilometre oscillation in the height of a satellite's perigee. The even terms in the multipolar expansion of the Earth's potential energy field could be obtained from the rate of rotation of the satellite's orbital plane and the odd terms came from the rate of change of eccentricity. Ground-based geodesists quickly saw their two centuries of laborious measurements of the Earth's shape completely upstaged by upstart space scientists.

King-Hele was helped by a host of amateur satellite spotters who provided accurate positional data, and he did an enormous amount of work to encourage these people by providing predictions of satellite positions. The media were helpful too. Satellites were burning out in the atmosphere at the rate of one every fortnight, and every time interest seemed to flag, a large satellite such as Cosmos 954 or Skylab enlivened the subject by scattering bits of metal over northern Canada and Australia. Friendly competition between King-Hele's group at RAE and the group at the Smithsonian Astrophysical Observatory also provided a spur. *Nature* published most of the results, and King-Hele fondly looks back on those happier days when "fortunately the refereeing system had not reached its present level of oppressiveness". With *A Tapestry of Orbits*, he has presented us with a first-class cocktail of science and life. □

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## Bones of contention

S. M. MacLaughlin-Black

**Bones: A Forensic Detective's Casebook.** By Douglas Ubelaker and Henry Scammell. Edward Burlingame Books (Harper Collins): 1992. Pp. 317. \$23.

THIS book presents a rapid-fire succession of cases in forensic osteology. They are recounted by Dr Douglas Ubelaker, a curator of anthropology in the National Museum of Natural History at the Smithsonian Institution in Washington. He is undoubtedly an experienced, conscientious, meticulous and busy scientist, but as an author he leaves one feeling unfulfilled and shell-shocked by the constant bombardment of often apparently unrelated and irrelevant cases.

Perhaps the co-writer is to blame — all we know about him is that he's an author. Yet the colloquial literary style, described on the dust jacket as having the "frisson of a thriller", falls far short of the ability to combine and capture our fascination with crime, detectives and murder. As such, the book's intended audience is not obvious.

But there are some light moments. On one occasion, Ubelaker is found trying to duplicate marks on a bone in an attempt to identify the implement used in a murder. He purchases some chicken wings, which he proceeds to slam in a car door and run over with a lawnmower. Truly the committed scientist.

The text contains several factual mistakes. For example, it has been known for some time that pits on the dorsal surface of the pubis cannot be considered evidence of parturition, and I was dismayed to find in the diagram of the skeleton that the authors think we have only five cervical vertebrae.

One particularly disturbing incident is reported with some obvious satisfaction. After having positively identified a body, Ubelaker was contacted by the victim's mother requesting confirmation from him that the victim was indeed her son, as the police had told her nothing. Without clearance from the investigative authorities, he took it upon himself to confirm the facts to her over the telephone. This would be gross professional misconduct in the United Kingdom.

Few books have been written on forensic osteology. Unfortunately, this one will do little to enhance the public image of the field and fails to capture its essence. □

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