Satellites as they cross the night sky look like moving stars, which can be accurately tracked by an observer with binoculars as well as by giant radars and large cameras. These observations help to determine the satellite's orbit, which is sensitive to the drag of the upper atmosphere and to any irregularities in the Earth's gravity field. Analysis of the orbit can be used to evaluate the density of the upper atmosphere and to define the shape of the Earth.

Desmond King-Hele was the pioneer of this technique of orbit analysis, and this book tells us how the research began, before the launch of Sputnik in 1957. For thirty years King-Hele and his colleagues at the Royal Aircraft Establishment, Farnborough, developed and applied the technique to reveal much about the Earth and air at a very modest cost. In the 1960s the upper-atmosphere density was thoroughly mapped out at heights of 100 to 2000 km, revealing immense variation of density with solar activity and between day and night. In the 1970s and 1980s a picture of the upper-atmosphere winds emerged, and the profile of the pear-shaped Earth was accurately charted. The number of satellites now orbiting the Earth is over 5000.

This book is the story of how this orbital research developed to yield a rich harvest of knowledge about the Earth and its atmosphere, in a scientific narrative that is enlivened with many personal experiences.

A TAPESTRY OF ORBITS

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DESMOND KING-HELE

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Preface

This book is a personal account of the researches based on analysis of satellite orbits between 1957 and 1990 at the Royal Aircraft Establishment, Farnborough, work in which I played a leading role. The book is most definitely not an impartial history of the subject world-wide: contributions by other groups are mentioned only when necessary. Nor is the book an autobiography, though the science is punctuated – and perhaps enlivened – by some personal experiences.

A book of this kind, a hybrid of science and life, presents the author with many stylistic problems. I have ruthlessly gouged out as many 'I's as possible, and have tried to avoid mentioning too many names (with apologies to all those who find themselves liquidated). I decided to use 'we' quite often: throughout the book *we* means 'those of us at the RAE who were concerned with or working on the problem'. Individual names are mentioned too, of course, and often the *we* is defined by giving the authors of a paper in a note.

I have tried to make the book widely intelligible to readers without specialized knowledge. There is a light sprinkling of mathematical equations: but if you don't like them you can skip them without losing the thread.

Most spacecraft chatter continuously, sending back to the ground stations so much data that storage can be quite a problem. The satellites selected for orbit analysis, on the other hand, are usually dumb (and deaf and blind): but they can be seen from the ground as they cross the sky, and from the observations their orbits can be determined. The changes in the orbits can be measured to obtain detailed information about the Earth's upper atmosphere and gravity field (from which the shape of the Earth can be derived). Thus small changes in satellite orbits lead to great changes in perceptions of the Earth and air. Acclaimed as the most cost-effective form

of space research in the 1960s, orbit analysis lost some of its shine in the 1970s, when wider horizons beckoned space scientists as expensive 'hitech' spacecraft came into vogue. By the 1980s orbit analysis was in a siding rather than on the main line of space research: but the techniques were improved and the work continued to produce new and relevant results, as the book demonstrates.