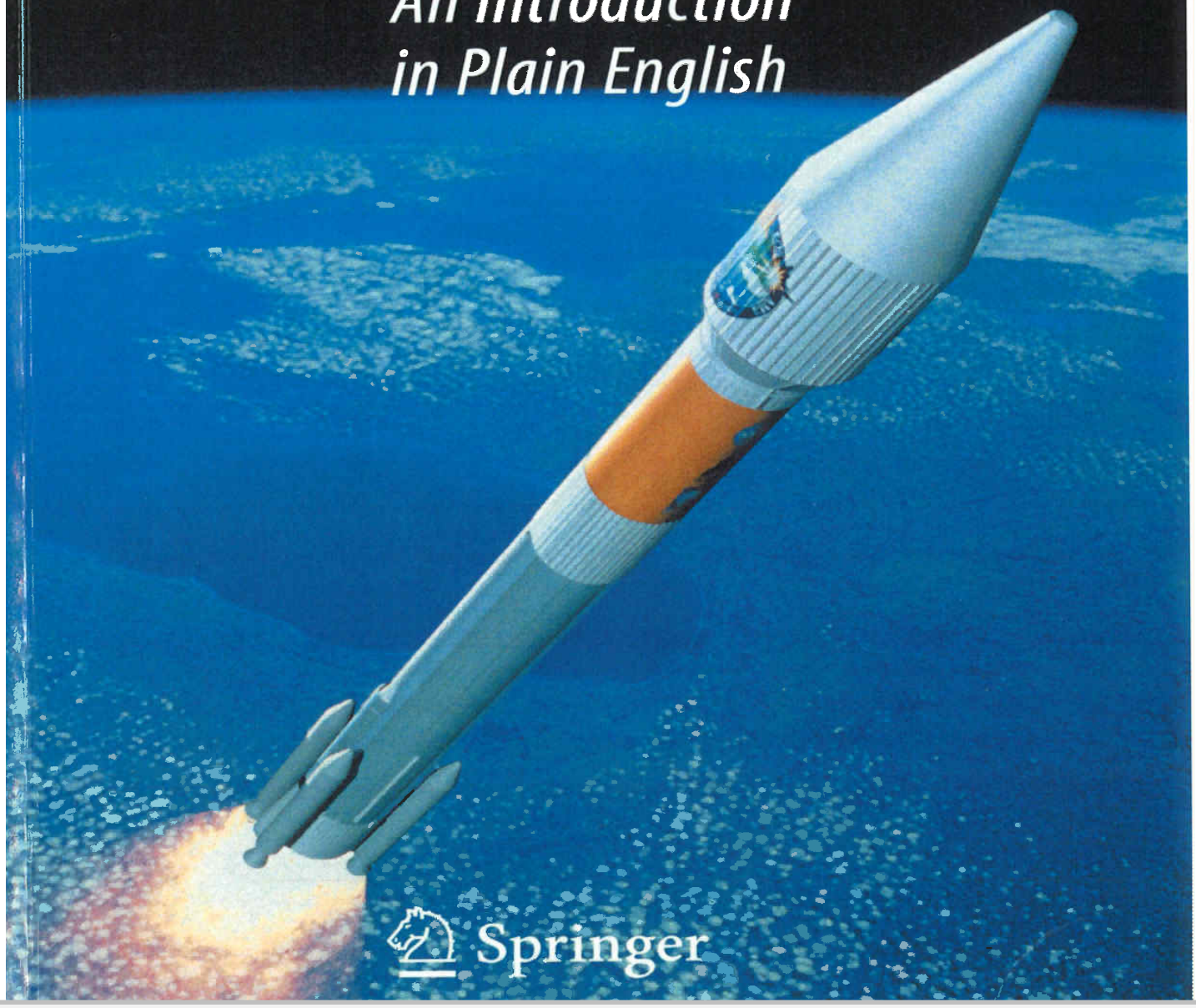
ASTRONOMERS' UNIVERSE

Lucy Rogers

It's ONLY Rocket Science

An Introduction in Plain English



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Dr. Lucy Rogers

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Dr. Lucy Rogers CEng MIMechE FRAS
Isle of Wight, UK.
www.itsonlyrocketscience.com

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1. Introduction

Non est ad astra mollis e terris via
(There is no easy way from the Earth to the stars)
Seneca, circa AD 50

On October 4, 1957, *Sputnik 1* became the first artificial satellite. It was launched into orbit by the former Soviet Union. The media coverage following the Soviet's success meant that the general public quickly became aware that rocket science was a scientific endeavour and no longer in the realms of science fiction. Rocket science has always been perceived as very challenging and the difficulties the Americans faced with their early launch failures reinforced this idea. Wernher von Braun, a major contributor to the development of rocket technology, both in Germany and later in the USA, said:

> It takes sixty-five thousand errors before you are qualified to make a rocket.

After the success of *Sputnik 1*, the launch and operation of satellites became very politically sensitive and so the brightest scientists and engineers were often employed as rocket scientists. It therefore became thought of as a subject only for the most intelligent. There are other fields of study that are arguably more challenging than rocket science, but, other than brain surgery, none have entered the mainstream vocabulary as a difficult thing to do.

This book aims to explain, in everyday terms, just what is involved in launching something into space and exploring the universe outside of our own small planet. It provides an overview into what is required for a mission, without the mathematical analysis of the fine detail. Such analysis is included in many good textbooks, some of which are listed in the bibliography. The rest of this chapter explains and defines some of the fundamental properties of space and rocket science that will be referred to throughout the book. The more technical aspects have been relegated to the Appendices, and, for simplicity, I have usually referred to all spacefaring humans as astronauts, no matter their citizenship or the country from which they launched.

Tsiolkovsky calculated many astronautical principles and designed rockets, but he never built any. At about the same time as he was working on his theoretical models, the American scientist Robert H. Goddard began to work seriously on rocket development, although neither knew of the other's work. Goddard was much more practical than Tsiolkovsky and by 1915 Goddard had carried out his first experiments involving solid-fuelled rockets. Both Goddard and Tsiolkovsky independently came to the conclusion that the solid fuels of the time would not be sufficient to power rockets to the height they believed would make it into space, but that liquid fuels would. Liquid-fuelled rockets are a lot more complex than solid-fuelled ones and involve many parts. Goddard launched the first liquid-fuelled rocket in 1926 and by the time he died in 1945 he had been granted many patents on various component rocket parts, including combustion chambers, nozzles, propellant feed systems and multistage launchers. Some of his patents still produce royalties for his estate. Goddard is regarded as the American Father of liquid-fuelled rockets.

By the 1930s there were rocket enthusiasts and rocket clubs in many countries including Germany, the Soviet Union and the USA. The German Society for Space Travel (Verein fuer Raumschiffahrt or VfR) was formed in 1927 with the Romanian born Hermann Oberth as one of its earliest members. In 1930 the VfR successfully tested a liquid-fuelled engine and by 1932 they were regularly flying rockets. Oberth wrote his doctoral thesis *The Rocket into Interplanetary Space* in 1922, but the University of Heidelberg rejected it and he was not given his doctorate. However, he believed in his ideas and published his thesis as *Die Rakete zu den Planetenräumen (By Rocket into Planetary Space)*, which he later expanded to become *Wege zur Raumschiffahrt (The Way to Space Travel)*. Oberth is regarded as the German Father of rocketry and his books described, amongst other things, a space station and liquid-fuelled rocket designs. Oberth influenced many scientists including the young Wernher von Braun. Von Braun joined the VfR as a teenager and assisted Oberth in his spare time.

During the First World War, rockets powered by solid propellants were used as weapons. The Treaty of Versailles, the peace treaty that officially ended the First World War, forbade solid-fuel rocket research in Germany. Liquid-fuelled rockets were not specifically forbidden and, by 1932, the German Army began to take an

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