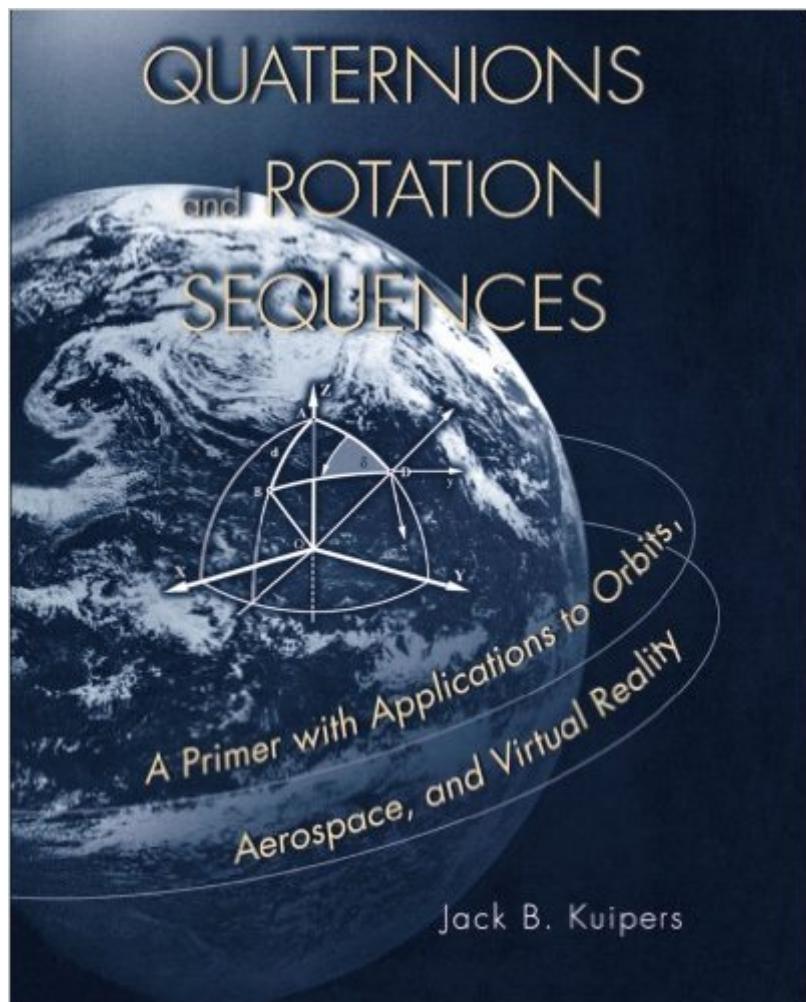


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# Quaternions And Rotation Sequences: A Primer With Applications To Orbits, Aerospace And Virtual Reality



## Synopsis

Ever since the Irish mathematician William Rowan Hamilton introduced quaternions in the nineteenth century--a feat he celebrated by carving the founding equations into a stone bridge--mathematicians and engineers have been fascinated by these mathematical objects. Today, they are used in applications as various as describing the geometry of spacetime, guiding the Space Shuttle, and developing computer applications in virtual reality. In this book, J. B. Kuipers introduces quaternions for scientists and engineers who have not encountered them before and shows how they can be used in a variety of practical situations. The book is primarily an exposition of the quaternion, a 4-tuple, and its primary application in a rotation operator. But Kuipers also presents the more conventional and familiar  $3 \times 3$  (9-element) matrix rotation operator. These parallel presentations allow the reader to judge which approaches are preferable for specific applications. The volume is divided into three main parts. The opening chapters present introductory material and establish the book's terminology and notation. The next part presents the mathematical properties of quaternions, including quaternion algebra and geometry. It includes more advanced special topics in spherical trigonometry, along with an introduction to quaternion calculus and perturbation theory, required in many situations involving dynamics and kinematics. In the final section, Kuipers discusses state-of-the-art applications. He presents a six degree-of-freedom electromagnetic position and orientation transducer and concludes by discussing the computer graphics necessary for the development of applications in virtual reality.

## Book Information

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## Customer Reviews

I merely want to share with you an excellent review of my Quaternion Book. The review appeared in the Nov/Dec'03 issue of Contemporary Physics, vol6., and was written by Dr Peter Rowlands, Waterloo University, UK. The review is herewith attached (if I may) otherwise I'll paste the text). It's probably too long --- but you now know where to find it. Here goes: The following Book Review Appeared in Journal: Contemporary Physics}, Nov/Dec 2003, vol 44, no. 6, pages 536 - 537 Å Å Å Å Å Quaternions & Rotation Sequences A Primer with Applications to Orbits, Aerospace, and Virtual Reality by JACK B. KUIPERS Princeton University Press. 2002, Å £24.95(pbk), pp. xxii +371, ISBN 0 691 10298 8. Scope: Text. Level: Postgraduate and Specialist. } Quaternions are one of the simplest and most powerful tools ever offered to the physicist or engineer. Unfortunately, they are relatively little known because a century-old prejudice (the result of a family feud involving vector theory) has been responsible for keeping them out of university courses. The fact that quaternions have never really found their true role has become a self-fulfilling prophecy, despite their reappearance in various disguised forms such as Pauli matrices, 4-vectors, and, in a complex double form, in the Dirac gamma algebra.

Latitude and longitude look simple enough, at first - just put your finger in the globe, and see which horizontal line crosses which vertical. When you start doing arithmetic, though, things get weird. Measuring longitude in degrees,  $179+2=-179$ . In degrees latitude,  $89+2=89$ , but the longitude changes! And, when you try to figure longitude precisely at the north pole, you run into a singularity. Believe me, you don't want to be in a plane when its navigation programs run into singularities. Those bits of strangeness all vanish when quaternions represent angles. Quaternions are a bit like complex numbers, but with three different complex parts instead of one. They have very nice mathematical properties, even better than rotation matrices, and a compact form. Kuipers gives a clear, thorough introduction to quaternions and their uses in geometric computations. Everything is explained one step at a time, giving the reader plenty of chance to back off and try again when the discussion gets thick. The buildup is very methodical, just about every derivation is carried out in steps that are easy to follow, using legible, standard notation. Kuipers uses side bars to remind the reader about the basics under more complex discussions, keeping an awareness of where a beginner might go off the rails. Since this discusses geometric computations, illustrations are profuse. The book is not for the reader in a hurry. There are lots of gems here, but you really do have to dig through a lot to find them. The illustrations contain all needed information, but it may take some effort to pick them apart. And, like any technical book, this assumes a reader with a certain background.

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