# *Notation*

The subject of vector geometry in general, and geometric algebra in particular, suffers from a profusion of notations and conventions. In short, there is no single convention that is perfectly suited to the entire range of applications of geometric algebra. For example, many of the formulae and results given in this book involve arbitrary numbers of vectors and are valid in vector spaces of arbitrary dimensions. These formulae invariably look neater if one does not embolden all of the vectors in the expression. For this reason we typically choose to write vectors in a lower case italic script, $a$, and more general multivectors in upper case italic script, $M$. But in some applications, particularly mechanics and dynamics, one often needs to reserve lower case italic symbols for coordinates and scalars, and in these situations writing vectors in bold face is helpful. This convention in adopted in chapter 3.

For many applications it is useful to have a notation which distinguishes frame vectors from general vectors. In these cases we write the former in an upright font as $\{\mathsf{e}_i\}$. But this notation looks clumsy in certain settings, and is not followed rigorously in some of the later chapters. In this book our policy is to ensure that we adopt a consistent notation within each chapter, and any new or distinct features are explained either at the start of the chapter or at their point of introduction.

Some conventions are universally adopted throughout this book, and for convenience we have gathered together a number of these here.

(i) The geometric (or Clifford) algebra generated by the vector space of signature $(p, q)$ is denoted $\mathcal{G}(p, q)$. In the first three chapters we employ the abbreviations $\mathcal{G}_2$ and $\mathcal{G}_3$ for the Euclidean algebras $\mathcal{G}(2, 0)$ and $\mathcal{G}(3, 0)$. In chapter 4 we use $\mathcal{G}_n$ to denote all algebras $\mathcal{G}(p, q)$ of total dimension $n$.

(ii) The geometric product of $A$ and $B$ is denoted by juxtaposition, $AB$.

(iii) The inner product is written with a centred dot, $A \cdot B$. The inner product is only employed between homogeneous multivectors.



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(iv) The outer (exterior) product is written with a wedge, $A \wedge B$. The outer product is also only employed between homogeneous multivectors.

(v) Inner and outer products are always performed before geometric products. This enables us to remove unnecessary brackets. For example, the expression $a \cdot b\, c$ is to be read as $(a \cdot b)c$.

(vi) Angled brackets $\langle M \rangle_p$ are used to denote the result of projecting onto the terms in $M$ of grade $p$. The subscript zero is dropped for the projection onto the scalar part.

(vii) The reverse of the multivector $M$ is denoted either with a dagger, $M^\dagger$, or with a tilde, $\tilde{M}$. The latter is employed for applications in spacetime.

(viii) Linear functions are written in an upright font as $\mathsf{F}(a)$ or $\mathsf{h}(a)$. This helps to distinguish linear functions from multivectors. Some exceptions are encountered in chapters 13 and 14, where caligraphic symbols are used for certain tensors in gravitation. The adjoint of a linear function is denoted with a bar, $\bar{\mathsf{h}}(a)$.

(ix) Lie groups are written in capital, Roman font as in $\mathrm{SU}(n)$. The corresponding Lie algebra is written in lower case, $\mathrm{su}(n)$.

Further details concerning the conventions adopted in this book can be found in sections 2.5 and 4.1.