

Versor Cheat Sheet

versor.mat.ucsb.edu

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Graphic Symbol	Geometric State	Grade(s)	Algebraic Form	Abbr.
	Scalar	0	α	Sca
	Vector	1	$\mathbf{a} = \alpha e_1 + \beta e_2 + \gamma e_3$	Vec
	Bivector	2	$\mathbf{B} = \mathbf{a} \wedge \mathbf{b}$	Biv
	Trivector	3	$\mathbf{I}_3 = \mathbf{a} \wedge \mathbf{b} \wedge \mathbf{c}$	Tri
	Point	1	$p = o + \mathbf{a} + \frac{1}{2}\mathbf{a}^2\infty$	Pnt
	Point Pair	2	$\tau = p_a \wedge p_b$	Par
	Circle	3	$\kappa = p_a \wedge p_b \wedge p_c$	Cir
	Sphere	4	$\Sigma = p_a \wedge p_b \wedge p_c \wedge p_d$	Sph
	Flat Point	2	$\Phi = p \wedge \infty$	Flp
	Line	3	$\Lambda = p_a \wedge p_b \wedge \infty$	Lin
	Dual Line	2	$\lambda = \mathbf{B} + \mathbf{d}\infty$	Dll
	Plane	4	$\Pi = p_a \wedge p_b \wedge p_c \wedge \infty$	Pln
	Dual Plane	1	$\pi = \mathbf{n} + \delta\infty$	Dlp
	Minkowski Plane	2	$E = o \wedge \infty$	Mnk
	Direction Vector	2	$t\infty$	Drv
	Direction Bivector	3	$\mathbf{B}\infty$	Drb
	Direction Trivector	4	$\mathbf{I}_3\infty$	Drt
	Tangent Vector	2	ot	Tnv
	Tangent Bivector	3	$o\mathbf{B}$	Tnb
	Tangent Trivector	4	$o\mathbf{I}_3$	Tnt
	Rotor	0, 2	$\mathcal{R} = e^{-\frac{\theta}{2}}\mathbf{B} = \cos\frac{\theta}{2} - \sin\frac{\theta}{2}\mathbf{B}$	Rot
	Translator	0, 2	$\mathcal{T} = e^{\frac{d}{2}\infty} = 1 - \frac{d}{2}\infty$	Trs
	Motor	0, 2, 4	$\mathcal{M} = e^{\mathbf{B} + d\infty}$	Mot
	Dilator	0, 2	$\mathcal{D} = e^{\frac{A}{2}E} = \cosh\frac{A}{2} + \sinh\frac{A}{2}E$	Dil
	Boost	0, 2	$\mathcal{B} = e^{ot} = 1 + ot$	Trv

Table 1: Basic elements of conformal geometric algebra and their algebraic constructions. The graphic symbols on the left are introduced to help reference the appendix of operations. Bold symbols represent Euclidean elements, with lowercase letters representing 1-blade vectors as is the custom in geometric algebra texts.

Operation	Operator or Method	Expression	Notation
Geometric Product	*	$A * B$	AB
Inner Product	\leq	$A \leq B$	$A B$
Outer Product	\wedge	$A \wedge B$	$A \wedge B$
Commutator	$\%$	$A \% B$	$A \times B$
Inverse	!	$!A$	A^{-1}
Reverse	\sim	$\sim A$	\tilde{A}
Conjugate	conjugation()	$A.\text{conjugation}()$	\bar{A}
Involute	involution()	$A.\text{involution}()$	\hat{A}

Table 2: How to perform basic operations on multivectors in *Versor*

Function	Output	Notation
<code>Op::sp(A,B) or A.sp(B)</code>	Spin A by B	$\mathcal{B}A\mathcal{B}^{-1}$
<code>Op::re(A,B) or A.sp(B)</code>	Reflect A by B	$\mathcal{B}\hat{A}\mathcal{B}^{-1}$
<code>Op::rj(A,B)</code>	Rejection of A from B	$(A \wedge B)B^{-1}$
<code>Op::pj(A,B)</code>	Projection of A onto B	$(A B)B^{-1}$
<code>Op::dl(A) or A.dual()</code>	The Dual of A	A^*
<code>Op::ud(A) or A.undual()</code>	The Undual of A	A^{-*}
<code>Op::dle(A) or A.duale()</code>	The Euclidean Dual of A	A^\star
<code>Op::ude(A) or A.unduale()</code>	The Euclidean Undual of A	$A^{-\star}$

Table 3: Some useful functions operating on one or two arguments.

Function	Output	Notation
Gen::log(Rot r)	The Bivector Generator of input \mathcal{R}	$\log(\mathcal{R})$
Gen::log(Mot m)	The Dual Line Generator of input \mathcal{M}	$\log(\mathcal{M})$
Gen::mot(Dll d)	The exponential \mathcal{M} of input Dual Line $B + d\infty$	$e^{B+d\infty}$
Gen::rot(Biv b)	The exponential \mathcal{R} of input Bivector θI	$e^{-\frac{\theta}{2}I}$
Gen::ratio(Vec a, Vec b)	The Rotor \mathcal{R} that takes input Vec a to input Vec b	$\frac{(1+ba)}{\sqrt{2(1+a\cdot b)}}$
Gen::ratio(Dll da, Dll db)	The Motor \mathcal{M} that takes input Dll A to input Dll B	
Gen::trs	The exponential \mathcal{T} of input Direction Vector $d\infty$	$e^{-\frac{d}{2}\infty}$
Gen::dil	The exponential \mathcal{D} of input E plane λE	$e^{\frac{\lambda}{2}E}$
Gen::trv	The exponential \mathcal{B} of input tangent vector	$e^{\frac{\alpha t}{2}}$
Gen::mat	The 4x4 matrix of input Rotor \mathcal{R}	$\begin{bmatrix} x_0 & y_0 & z_0 & 0 \\ x_1 & y_1 & z_1 & 0 \\ x_2 & y_2 & z_2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
Gen::aa	The axis angle rep of input Rotor \mathcal{R}	$[\theta \ x \ y \ z]$

Table 4: Common functions for dealing with versors and their generators.

Function	Output
Ro::null	Point p map of input Vector v
Ro::dls	Dual Sphere from input Vector v and radius α
Ro::split1	Point p of input Point Pair $p \wedge q$
Ro::split2	Point q of input Point Pair $p \wedge q$
Ro::sur	Dual Sphere Surrounding input
Ro::cen	Center point p of input Round
Ro::car	Carrier Plane or Line of Input Circle or Point Pair
Ro::size	Squared Radius (+ or -) of input Round
Ro::wt	Weight α of input Round

Table 5: Common functions for creating and querying round elements

Function	Output
<code>F1::car</code>	Carrier Plane or Line of Input Circle or Point Pair
<code>F1::loc</code>	Point p on input line or plane closest to input point
<code>F1::wt</code>	Weight α of input Flat
<code>F1::dir</code>	Direction of input Flat

Table 6: Common functions for creating and querying flat elements

Function	Output
<code>Ta::at</code>	Tangent to input State at input point p
<code>Ta::wt</code>	Weight α of input Tangent

Table 7: Common functions for creating and querying tangent elements

Appendix A: List of Operators By Return Type

Operations that Construct a Point						
$I_5 \ominus$	$\bullet\bullet \lrcorner \bigcirc$	$\bullet\bullet \lrcorner \searrow$	$\bigcirc \lrcorner \ominus$	$\bigcirc \lrcorner \swarrow$	$\lrcorner \lrcorner \bigcirc$	$\bullet \lrcorner \bullet\bullet$
Pss * Sph	Par Cir	Par Lin	Cir Sph	Cir Pln	Dll Cir	Dlp Par
Operations that Construct a Sphere						
$I_5 \bullet$	$\bullet \wedge \bigcirc$	$\bullet\bullet \wedge \bullet\bullet$	$\bullet\bullet \wedge \lrcorner$	$\bullet\bullet \wedge \curvearrowleft$	$\bigcirc \wedge \bullet$	$\bigcirc \wedge \nearrow$
Pss * Pnt	Pnt \wedge Cir	Par \wedge Par	Par \wedge Dll	Par \wedge Biv	Cir \wedge Dlp	Cir \wedge Vec
Operations that Construct a Point Pair						
$I_5 \bigcirc$	$\bullet \wedge \bullet$	$\bullet \lrcorner \bigcirc$	$\bullet \lrcorner \searrow$	$\bullet \wedge \bullet$	$\lrcorner \lrcorner \bigcirc$	$\bullet \lrcorner \bigcirc$
Pss * Cir	Pnt \wedge Pnt	Pnt Cir	Pnt Lin	Pnt \wedge Dlp	Dll Sph	Dlp Cir
$\nearrow \lrcorner \bigcirc$						
Vec Cir						
Operations that Construct a Circle						
$I_5 \bullet\bullet$	$\bullet \wedge \bullet\bullet$	$\bullet \lrcorner \ominus$	$\bullet \lrcorner \swarrow$	$\bullet \wedge \lrcorner$	$\bullet\bullet \wedge \bullet$	$\bullet\bullet \wedge \nearrow$
Pss * Par	Pnt \wedge Par	Pnt Sph	Pnt Pln	Pnt \wedge Dll	Par \wedge Dlp	Par \wedge Vec
$\bullet \lrcorner \bigcirc$						
Dlp Sph						

Operations that Construct a Line

$$\begin{array}{ccccccc}
 \infty \wedge \bullet \bullet & I_5 \swarrow & \bullet \circlearrowleft \nearrow & \bullet \circlearrowleft \wedge \infty & \infty \wedge \bullet \triangle & \infty \wedge \nearrow & \bullet \triangle \swarrow \\
 \text{Inf} \wedge \text{Par} & \text{Pss} * \text{D11} & \text{Pnt} \wedge \text{Drv} & \text{Pnt} \wedge \text{Flp} & \text{Flp} \wedge \text{Dlp} & \text{Flp} \wedge \text{Vec} & \text{Dlp} \downarrow \text{Pln} \\
 \\
 \nearrow \downarrow \swarrow & & & & & & \\
 \text{Vec} \downarrow \text{Pln} & & & & & &
 \end{array}$$

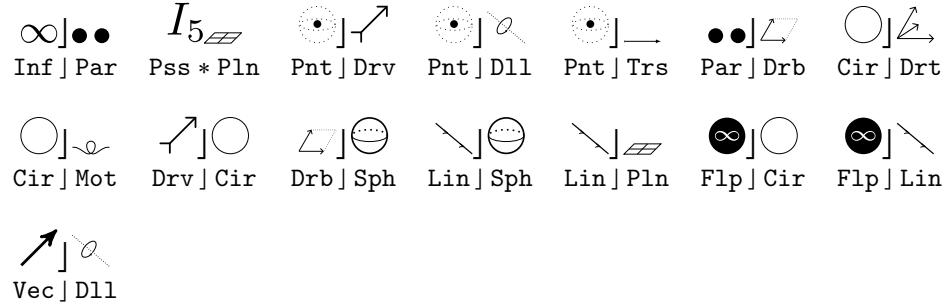
Operations that Construct a Dual Line

$$\begin{array}{ccccccc}
 \infty \downarrow \bigcirc & I_5 \searrow & \bullet \circlearrowright \downarrow \swarrow & \bullet \bullet \downarrow \nearrow & \nearrow \downarrow \bigcirc & \infty \downarrow \bigcirc & \infty \downarrow \swarrow \\
 \text{Inf} \downarrow \text{Cir} & \text{Pss} * \text{Lin} & \text{Pnt} \downarrow \text{Drb} & \text{Par} \downarrow \text{Drt} & \text{Drv} \downarrow \text{Sph} & \text{Flp} \downarrow \text{Sph} & \text{Flp} \downarrow \text{Pln} \\
 \\
 \bullet \triangle \wedge \bullet \triangle & \bullet \triangle \wedge \nearrow & & & & & \\
 \text{Dlp} \wedge \text{Dlp} & \text{Dlp} \wedge \text{Vec} & & & & &
 \end{array}$$

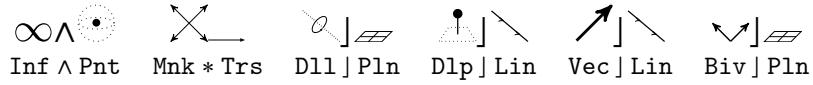
Operations that Construct a Plane

$$\begin{array}{ccccccc}
 \infty \wedge \bigcirc & I_5 \bullet & \bullet \circlearrowleft \swarrow & \bullet \circlearrowleft \wedge \searrow & \bullet \bullet \wedge \nearrow & \bullet \bullet \wedge \infty & \searrow \wedge \bullet \triangle \\
 \text{Inf} \wedge \text{Cir} & \text{Pss} * \text{Dlp} & \text{Pnt} \wedge \text{Drb} & \text{Pnt} \wedge \text{Lin} & \text{Par} \wedge \text{Drv} & \text{Par} \wedge \text{Flp} & \text{Lin} \wedge \text{Dlp} \\
 \\
 \searrow \wedge \nearrow & \infty \wedge \swarrow & \infty \wedge \nwarrow & & & & \\
 \text{Lin} \wedge \text{Vec} & \text{Flp} \wedge \text{D11} & \text{Flp} \wedge \text{Biv} & & & &
 \end{array}$$

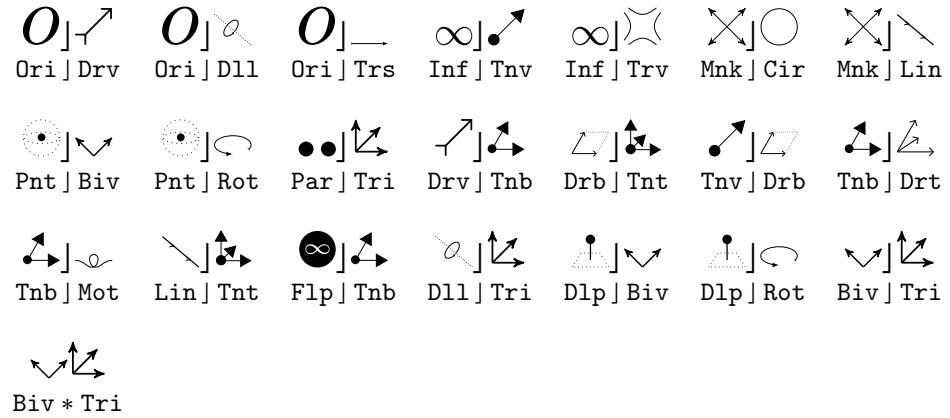
Operations that Construct a Dual Plane



Operations that Construct a Flat Point



Operations that Construct a Vector



Operations that Construct a Bivector

$$\begin{array}{ccccccc}
 O_{\downarrow \swarrow} & \infty_{\downarrow \curvearrowleft} & \times_{\downarrow \odot} & \times_{\downarrow \swarrow} & \circlearrowleft_{\downarrow \curvearrowright} & \nearrow_{\downarrow \curvearrowright} & \bullet_{\downarrow \swarrow} \\
 \text{Ori} \downarrow \text{Drb} & \text{Inf} \downarrow \text{Tnb} & \text{Mnk} \downarrow \text{Sph} & \text{Mnk} \downarrow \text{Pln} & \text{Pnt} \downarrow \text{Tri} & \text{Drv} \downarrow \text{Tnt} & \text{Tnv} \downarrow \text{Drt} \\
 \\
 \bullet_{\infty \downarrow \curvearrowright} & \triangle_{\downarrow \curvearrowright} & \nearrow \wedge \nearrow & \nearrow \downarrow \curvearrowright & \nearrow \downarrow \curvearrowright & & \\
 \text{Flp} \downarrow \text{Tnt} & \text{Dlp} \downarrow \text{Tri} & \text{Vec} \wedge \text{Vec} & \text{Vec} \downarrow \text{Tri} & \text{Vec} * \text{Tri} & &
 \end{array}$$

Operations that Construct a Trivector

$$\begin{array}{ccccc}
 O_{\downarrow \swarrow} & \infty_{\downarrow \curvearrowright} & \times_{\downarrow} I_5 & \times_{\downarrow} I_5 & \nearrow \wedge \nearrow \\
 \text{Ori} \downarrow \text{Drt} & \text{Inf} \downarrow \text{Tnt} & \text{Mnk} \downarrow \text{Pss} & \text{Mnk} * \text{Pss} & \text{Vec} \wedge \text{Biv}
 \end{array}$$

Operations that Construct a Direction Vector

$$\begin{array}{ccccccc}
 \infty_{\searrow} & \infty_{\nwarrow} & \infty \wedge \bullet_{\downarrow} & \infty_{\bullet} & \infty \wedge \nearrow & \infty_{\nearrow} & I_{5 \downarrow} \\
 \text{Inf} \downarrow \text{Lin} & \text{Inf} * \text{Lin} & \text{Inf} \wedge \text{Dlp} & \text{Inf} * \text{Dlp} & \text{Inf} \wedge \text{Vec} & \text{Inf} * \text{Vec} & \text{Pss} * \text{Drb} \\
 \\
 \swarrow_{\downarrow \curvearrowleft} & \swarrow_{\swarrow \parallel} & \swarrow_{\bullet} & \swarrow_{\curvearrowleft \curvearrowright} & \swarrow_{\downarrow \swarrow} & \nearrow_{\downarrow \swarrow} & \\
 \text{Drb} * \text{Tri} & \text{Drt} * \text{Pln} & \text{Drt} * \text{Dlt} & \text{Drt} * \text{Biv} & \text{Dlp} \downarrow \text{Drb} & \text{Vec} \downarrow \text{Drb} &
 \end{array}$$

Operations that Construct a Direction Bivector

$$\begin{array}{ccccccc}
 \infty_{\parallel} & \infty_{\parallel} & \infty \wedge \bullet_{\swarrow} & \infty_{\bullet} & \infty \wedge \nearrow & \infty_{\nearrow} & I_{5 \nearrow} \\
 \text{Inf} \downarrow \text{Pln} & \text{Inf} * \text{Pln} & \text{Inf} \wedge \text{Dlt} & \text{Inf} * \text{Dlt} & \text{Inf} \wedge \text{Biv} & \text{Inf} * \text{Biv} & \text{Pss} * \text{Drv} \\
 \\
 \nearrow \wedge \bullet_{\downarrow} & \nearrow \wedge \nearrow & \nearrow \downarrow \curvearrowleft & \swarrow_{\curvearrowleft \curvearrowright} & \swarrow_{\bullet} & \swarrow_{\nearrow} & \\
 \text{Drv} \wedge \text{Dlp} & \text{Drv} \wedge \text{Vec} & \text{Drv} * \text{Tri} & \text{Drt} * \text{Lin} & \text{Drt} * \text{Dlp} & \text{Drt} * \text{Vec} &
 \end{array}$$

Operations that Construct a Direction Trivector

$$\begin{array}{ccccccc}
 \infty \downarrow I_5 & \infty I_5 & \infty \wedge \uparrow \leftarrow & \infty \uparrow \leftarrow & \nearrow \wedge \circlearrowleft & \nearrow \wedge \curvearrowleft & \square \wedge \bullet \\
 \text{Inf} \downarrow \text{Pss} & \text{Inf} * \text{Pss} & \text{Inf} \wedge \text{Tri} & \text{Inf} * \text{Tri} & \text{Drv} \wedge \text{Dl1} & \text{Drv} \wedge \text{Biv} & \text{Drb} \wedge \text{Dlp} \\
 \\
 \square \wedge \nearrow & \circlearrowleft \wedge \circlearrowleft & \circlearrowleft \wedge \curvearrowleft & \bullet \wedge \uparrow \leftarrow & & & \\
 \text{Drb} \wedge \text{Vec} & \text{Dl1} \wedge \text{Dl1} & \text{Dl1} \wedge \text{Biv} & \text{Dlp} \wedge \text{Tri} & & &
 \end{array}$$

Operations that Construct a Tangent Vector at Origin

$$\begin{array}{ccccccc}
 O \wedge \nearrow & O \nearrow & I_5 \rightarrow & \rightarrow \uparrow \leftarrow & \uparrow \rightarrow \curvearrowleft & \nearrow \downarrow \rightarrow \\
 \text{Ori} \wedge \text{Vec} & \text{Ori} * \text{Vec} & \text{Pss} * \text{Tnb} & \text{Tnb} * \text{Tri} & \text{Tnt} * \text{Biv} & \text{Vec} \downarrow \text{Tnb} & \\
 \end{array}$$

Operations that Construct a Tangent Bivector at Origin

$$\begin{array}{ccccccc}
 O \wedge \curvearrowleft & O \curvearrowleft & I_5 \rightarrow & \rightarrow \wedge \nearrow & \bullet \wedge \uparrow \leftarrow & \uparrow \rightarrow \wedge \curvearrowleft & \uparrow \rightarrow \wedge \nearrow \\
 \text{Ori} \wedge \text{Biv} & \text{Ori} * \text{Biv} & \text{Pss} * \text{Tnv} & \text{Tnv} \wedge \text{Vec} & \text{Tnv} * \text{Tri} & \text{Tnt} * \text{Vec} & \\
 \end{array}$$

Operations that Construct a Tangent Trivector at Origin

$$\begin{array}{ccccccc}
 O \downarrow I_5 & O I_5 & O \wedge \leftarrow & O \uparrow \leftarrow & \bullet \wedge \curvearrowleft & \rightarrow \wedge \nearrow & \\
 \text{Ori} \downarrow \text{Pss} & \text{Ori} * \text{Pss} & \text{Ori} \wedge \text{Tri} & \text{Ori} * \text{Tri} & \text{Tnv} \wedge \text{Biv} & \text{Tnb} \wedge \text{Vec} & \\
 \end{array}$$

Operations that Construct a Rotor

$$\begin{array}{cccc}
 \bullet \rightarrow \downarrow \circlearrowleft & \nearrow \nearrow & \curvearrowleft \curvearrowleft \curvearrowright & \circlearrowleft \downarrow \curvearrowright \\
 \text{Tnv} \downarrow \text{Mot} & \text{Vec} * \text{Vec} & \text{Biv} * \text{Biv} & \text{Mot} \downarrow \text{Biv} \\
 \end{array}$$

Operations that Construct a Translator

$$\begin{array}{ccccc} \text{Mnk} * \text{Flp} & \text{Flp} * \text{Flp} & \text{Dll} \sqcup \text{Mot} & \text{Biv} \sqcup \text{Mot} & \text{Trv} \sqcup \text{Drv} \\ \text{X}(\infty) & (\infty\infty) & \text{O}\sqcup\text{o} & \text{V}\sqcup\text{o} & \text{C}\sqcup\text{r} \end{array}$$

Operations that Construct a Dilator

$$\begin{array}{cc} O_\infty & \text{Drt} * \text{Tnt} \\ \text{Ori} * \text{Inf} & \text{A}\nearrow\text{r} \end{array}$$

Operations that Construct a Motor

$$\begin{array}{ccccccc} \text{Lin} * \text{Lin} & \text{Dll} * \text{Dll} & \text{Dll} * \text{Biv} & \text{Dll} * \text{Rot} & \text{Rot} \wedge \text{Trs} & \text{Rot} * \text{Trs} \\ \text{--}\diagup & \text{O}\diagup\text{o} & \text{O}\swarrow\text{v} & \text{O}\circlearrowleft & \curvearrowleft\wedge\longrightarrow & \curvearrowright\longrightarrow \end{array}$$

Operations that Construct a Transversor

$$\begin{array}{cc} \text{Trs} \sqcup \text{Tnv} & \text{Mot} \sqcup \text{Tnv} \\ \text{---}\sqcup\bullet\rightarrow & \text{o}\sqcup\bullet\rightarrow \end{array}$$

Operations that Construct a Motor Dilator

$$\begin{array}{cccc} \text{Par} * \text{Drv} & \text{Cir} * \text{Drb} & \text{Dil} \wedge \text{Mot} & \text{Dil} * \text{Mot} \\ \bullet\bullet\rightarrow & \text{O}\triangleleft & \text{O}\wedge\text{o} & \text{O}\circlearrowleft\text{o} \end{array}$$

Operations that Construct a Minkowski Plane

$$\begin{array}{cc} O_{\wedge\infty} & I_5\swarrow \\ \text{Ori} \wedge \text{Inf} & \text{Pss} * \text{Tri} \end{array}$$

Operations that Construct a Pseudoscalar

$O \wedge \odot$	$O \wedge \triangleleft$	$O \wedge \equiv$	$\infty \wedge \odot$	$\infty \wedge \bullet \rightarrow$	$\times \wedge \circlearrowleft$	$\times \wedge \uparrow \downarrow$
Ori \wedge Sph	Ori \wedge Drt	Ori \wedge Pln	Inf \wedge Sph	Inf \wedge Tnt	Mnk \wedge Cir	Mnk \wedge Tri
$\times \wedge \uparrow \downarrow$	$\odot \wedge \odot$	$\odot \wedge \triangleleft$	$\odot \wedge \bullet \rightarrow$	$\odot \wedge \equiv$	$\bullet \bullet \wedge \circlearrowleft$	$\bullet \bullet \wedge \triangleleft$
Mnk \wedge Tri	Pnt \wedge Sph	Pnt \wedge Drt	Pnt \wedge Tnt	Pnt \wedge Pln	Par \wedge Cir	Par \wedge Drb
$\bullet \bullet \wedge \bullet \rightarrow$	$\bullet \bullet \wedge \backslash$	$\bullet \bullet \wedge \uparrow \downarrow$	$\circlearrowleft \wedge \nearrow$	$\circlearrowleft \wedge \bullet \nearrow$	$\circlearrowleft \wedge \infty$	$\circlearrowleft \wedge \times$
Par \wedge Tnb	Par \wedge Lin	Par \wedge Tri	Cir \wedge Drv	Cir \wedge Tnv	Cir \wedge Flp	Cir \wedge Dll
$\circlearrowleft \wedge \curvearrowleft$	$\odot \wedge \bullet$	$\odot \wedge \nearrow$	$\nearrow \wedge \bullet \rightarrow$	$\nwarrow \wedge \bullet \nearrow$	$\bullet \nearrow \wedge \backslash$	$\bullet \nearrow \wedge \infty$
Cir \wedge Biv	Sph \wedge Dlp	Sph \wedge Vec	Drv \wedge Tnb	Drv \wedge Tnv	Tnv \wedge Lin	Tnb \wedge Flp
$\bullet \nearrow \wedge \times$	$\bullet \nearrow \wedge \bullet$	$\backslash \wedge \times$	$\backslash \wedge \curvearrowleft$	$\equiv \wedge \bullet$	$\equiv \wedge \nearrow$	$\infty \wedge \uparrow \downarrow$
Tnb \wedge Dll	Tnt \wedge Dlp	Lin \wedge Dll	Lin \wedge Biv	Pln \wedge Dlp	Pln \wedge Vec	Flp \wedge Tri

Operations that Construct an Origin

$I_{5 \bullet \rightarrow}$	$\bullet \rightarrow \triangleleft$	$\nearrow \downarrow \bullet \rightarrow$	$\nearrow \downarrow \odot$	$\nearrow \downarrow \times$
Pss \star Tnt	Tnt \star Tri	Vec \downarrow Tnv	Vec \downarrow Trv	Biv \downarrow Tnb

Operations that Construct an Infinity

$I_{5 \triangleleft}$	$\nearrow \downarrow \backslash$	$\square \downarrow \equiv$	$\triangleleft \wedge \uparrow \downarrow$	$\odot \downarrow \triangleleft$	$\odot \downarrow \backslash$	$\bullet \downarrow \times$
Pss \star Drt	Drv \downarrow Lin	Drb \downarrow Pln	Drt \star Tri	Dll \downarrow Drb	Dll \downarrow Lin	Dlp \downarrow Mnk
$\bullet \downarrow \nearrow \rightarrow$	$\bullet \downarrow \infty$	$\bullet \downarrow \rightarrow$	$\bullet \downarrow \odot$	$\nearrow \downarrow \backslash$	$\nearrow \downarrow \infty$	$\nearrow \downarrow \rightarrow$
Dlp \downarrow Drv	Dlp \downarrow Flp	Dlp \downarrow Trs	Dlp \downarrow Dil	Vec \downarrow Drv	Vec \downarrow Flp	Vec \downarrow Trs
$\nearrow \downarrow \triangleleft$	$\nearrow \downarrow \backslash$	$\uparrow \downarrow \equiv$	$\uparrow \downarrow \odot$			
Biv \downarrow Drb	Biv \downarrow Lin	Tri \downarrow Pln	Tri \downarrow Mot			