

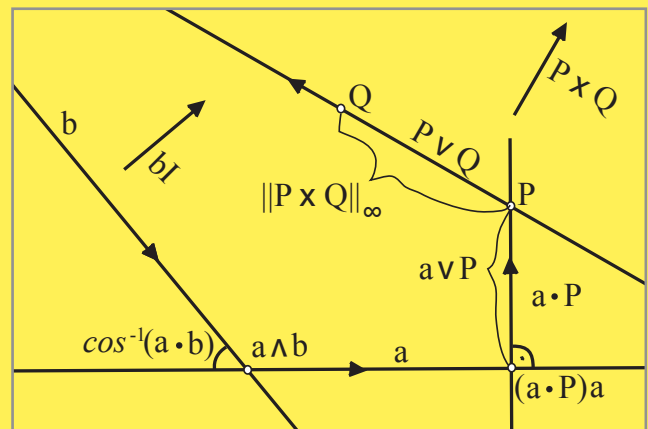
A Short Course on Projective Geometric Algebra



The discovery of geometric algebra by William Clifford in 1878 was the climax of a profound stream of 19th century European mathematics. It unified other “geometric algebras” (such as Hamilton’s quaternions (1843), Grassmann algebras (1844), and his own biquaternions (1873)) into a single algebra featuring a “geometric product”, whereby points lines and planes are at the same time “number”, that can be added, multiplied, inverted, exponentiated, used in equations – each operation faithfully mirroring the structure of the geometry.

This course develops geometric algebra as it originated in Clifford’s time, within projective geometry, hence the name “projective geometric algebra (PGA)”. The key ingredient is the Cayley-Klein construction (1859), creating metric spaces within projective space by specialising the cross ratio with respect to a chosen polarity, called the Absolute.

EXAMPLE: In 2D PGA, if p represents a line, then its normal vector N is its polar point with respect to the Absolute, and the reflection in p is the unique harmonic homology that fixes p and N . This appears in PGA as the geometric product pXp , a formula valid for any geometry X (point or line) and any choice of Absolute. The figure above shows examples of the 2D euclidean geometric product.



Developments in the 21st century extending PGA to Euclidean space involved building space out of planes rather than points. These were made possible by PGA’s natural “double algebra” approach. Hence PGA provides a unified structure integrating space and counterspace. In this context, the course will explore George Adams’ interest in geometric algebra as expressed in “Letter to Olive Whicher” and his investigations of rigid body mechanics.

The course will present PGA in 1, 2, and 3 dimensions, with exercise sessions, and text study centered on the relation of geometry and algebra. Students should have some experience with university-level mathematics, and be on good terms with projective geometry. A detailed schedule and registration directions are available on the next page.

Russell Arnold & Charlie Gunn

Course Schedule

	Wednesday 9.10	Thursday 10.10	Friday 11.10
9-10:30	Introduction	2D PGA elliptic and hyperbolic	3D PGA
10:30-11:00	Coffee break	Coffee break	Coffee break
11:00-12:30	1D PGA All metrics	2D PGA Euclidean	3D PGA Line geometry
12:30-14:30	Lunch break	Lunch break	Lunch break
14:30-16:00	Exercises	Exercises	Exercises
16:00-16:30	Coffee break	Coffee break	Coffee break
16:30-18:00	Text study Geometry and Algebra	Text study "Letter to Olive Whicher"	Review and Discussion
18:00-20:00	Dinner break	Dinner break	
20:00-21:30	Free evening	TBA	Schedule is subject to change.

Registration

Please register by 01 October via:
<https://goetheanum.ch/en/events/PGA>
Phone +41 61 706 44 44

The course will be held in English without translation. German-speaking attendees are encouraged to ask questions in German.

Course costs (3 lunches and 2 dinners included):
Support price 490 CHF
Regular price 390 CHF
Reduced price 240 CHF
Student price 240 CHF

If you plan to attend, please contact Charlie Gunn (cgunn3@gmail.com) to receive preparatory mailings regarding the course, or if you have any questions about the course.

Presenters

Charlie Gunn, Ph. D., born 1952, is a life-long student of projective geometry and a founder of projective geometric algebra. He is inspired by George Adams' life-work of integrating the thought forms of projective geometry into the language of science.

Russell Arnold, Ph. D., born 1993, is a mathematician and anthroposophist who has worked on research in projective geometry at the mathematical and astronomical section of the Goetheanum since 2023.

Course Location:

The course will be held in the Conference Room of the Goetheanum in Dornach, Switzerland.

Math.-Astr. Section, Dornach, Switzerland

October 9-11, 2024