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Seminar in the Department
of Physics
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Gyrogroups and Gyrovector Spaces
In Relativity Physics
And In Hyperbolic Geometry

ABSTRACT: Hyperbolic geometry is a fundamental aspect of modern physics. It turns out that both (i) Einstein's addition from relativity physics, and (ii) Möbius addition from geometry play in hyperbolic geometry the role that the common vector addition plays in Euclidean geometry. Both (i) Einstein's addition and (ii) Möbius addition are neither commutative nor associative, so they are not group operations. Surprisingly, they turn out to be gyrogroup operations that give rise to gyrogroups and gyrovector spaces. Furthermore, (i) the Einstein gyrovector spaces form the setting for the Beltrami model of hyperbolic geometry and (ii) the Möbius gyrovector spaces form the setting for the Poincaré model of hyperbolic geometry in the same way that (iii) the common vector spaces form the setting for the common model of Euclidean geometry.

Gyrogroups and gyrovector spaces thus capture analogies with groups and vector spaces enabling, for instance, parallel transport along hyperbolic geodesics to be done algebraically by methods of nonassociative algebra rather than differential geometry. Connections with Riemannian geometry will be presented.

This talk is an introduction to a Mathematics-Physics Joint-Seminar, that will be offered this summer, May 15 - June 8, 2001, (2 credits) based on the speaker's forthcoming book: *"Beyond the Einstein Addition Law and its Gyroscopic Thomas Precession: The Theory of Gyrogroups and Gyrovector Spaces"* (Kluwer Acad. Inc., 2001).

Those who, following the talk, now believe that *"Placing the Einstein Addition Centrally in Special Relativity Theory: [is] An Idea Whose Time Has Come Back"* are invited to download a preprint under this title, from the speaker's website:

www.math.ndsu.NoDak.edu/faculty/ungar/publications.html