INTERNATIONAL SCIENTIFIC CONFERENCE "INFINITE-DIMENSIONAL ANALYSIS AND MATHEMATICAL PHYSICS"

Dedicated to the memory of
Sergei Vasilyevich Fomin

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Laboratory
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MIPT

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Luigi Accardi

Quantum extensions of the exotic Laplacians and associated quantum heat semi–groups

The hierarchy of exotic Laplacians was introduced in the paper:
Accardi L., Smolyanov O.G.:
On Laplacians and Traces,
Conferenze del Seminario di Matematica dell'Università di Bari, 250 (1993) 1-28, Volterra preprint N. 141 (1993)
as a natural extension of the usual Levy Laplacian. In the present talk it is shown that the heat semi–group associated to each Laplacian in the above mentioned hierarchy admits a natural and explicit quantum extension in which the Weyl operators are eigen–operators of the given Laplacian, just as trigonometric exponentials are eigenvectors of the usual Laplacian. This is joint work with Un Cig Ji and Kimiaki Saito.

Semjon Adlaj

Galois axis

A nowadays famous calculation of a "spin to wobble rate" which "came out of a complicated equation!", carried out by Richard Feynman, confirmed an assumption, which "was pretty obvious" to him, where "the spinning went on faster than the wobbling". Benjamin Chao, having investigated "the Chandler wobble phenomenon", knew the correct ratio before he came across Feynman's calculation in 1989 (after Feynman's death) and found it to be erroneous, along with its underlying assumption, so he wrote in clarification that "a torque free plate wobbles twice as fast as it spins when the wobble angle is slight. The ratio of spin to wobble rates is 1:2 not 2:1!".

Feynman went on telling us that "the diagrams and the whole business that I got the Nobel Prize for came from that piddling around with the wobbling plate." Perhaps, his little, yet inspiring, story is even more amusing (and more telling) than he thought, as he (inadvertently) reveals that he did not learn (or know) a (correct) solution to his problem, given by James Clerk Maxwell who had (incidentally!) cautioned in 1857 that:

"The theory of the rotation of a rigid system is strictly deduced from the elementary laws of motion, but the complexity of the motion of the particles of a body freely rotating renders the subject so intricate, that it has never been thoroughly understood by any but the most expert mathematicians. Many who have mastered the lunar theory have come to erroneous conclusions on this subject; and even Newton has chosen to deduce the disturbance of the earth's axis from his theory of the motion of the nodes of a free orbit, rather than attack the problem of the rotation of a solid body."

Indeed, a most striking observation, made in 1985 (June 25th) by the Soviet cosmonaut Vladimir Dzhanibekov, became known (yet over a decade later) via a video demonstration (from the "Mir" space station) as "the Dzhanibekov effect". With the advent of "Utube" it got the attention of Terrence Tao (in 2011) who shared his interpretation publicly on "Google+":

"The tennis racket theorem asserts that when rotating a rigid body with three distinct moments of inertia, the rotation around the axes with the largest or smallest moments of inertia is stable, but the rotation around the axis with the intermediate moment of inertia is unstable. Indeed, in the latter case the object will (when one looks just at the angular velocities) typically traverse periodically through the space of all states with the given angular momentum and energy, which is a closed curve known as a herpolhode that will pass close to both antipodes of the unstable equilibrium in an alternating fashion."

A more accurate description of "the twisting tennis racket" phenomenon was given in a 1991 eponymous article by Mark Ashbaugh, Carmen Chiconc and Richard Cushman:

"The classical treatments of the dynamics of a tennis racket about its intermediate axis fail to describe a remarkable aspect of its motion which is revealed in the following experiment. Mark the faces of the racket so that they can be distinguished. Call one rough and the other smooth. Hold the racket horizontally by its handle with the smooth face up. Toss the racket into the air attempting to make it rotate about the intermediate axis (namely, the axis in the plane of the face which is perpendicular to the handle). After one rotation, catch the racket by the handle. The rough face will almost always be up! In other words, the racket typically makes a half-twist about its handle."

The three authors go on (justly) stating that:

"The twisting phenomenon seems to be new. It is not mentioned in a recent article on the Eulerian wobble (Colley, 1987), in general texts on classical mechanics (Arnol'd, 1978; Goldstein, 1950; Landau and Lifschitz, 1976), or in specialized texts on rigid body motion (Klein and Sommerfeld, 1897-1910; Webster, 1920)."

"The experiment" appears to be due to William Burke, whose life was tragically abrupted in 1996 (before Dzhanibekov's observation reached him). Yet he brought to our attention a key observation "a half-twist" which is as crucially relevant in describing the motion of Dzhanibekov wingnut as it is relevant for describing the motion of the tennis racket. Recent articles, devoted to Dzhanibekov's observation, have fallen short from delving into explicit mathematical reconstruction, leaving (in particular) the determination of whether the "half-twist" of the racket occurs about its handle or about some other "nearby" axis!? Such an axis has been (provenly) justifiably called a "Galois axis"! It is fixed within a rigid body, representing an axis of a "generalized" symmetry. In fact, for a dynamically symmetric rigid body, Galois axis does coincide with the axis of symmetry but whenever the moments of inertia are pairwise distinct it no longer coincides with any principal axis of inertia. Galois axis is orthogonal to the circular sections of MacCullagh ellipsoid (of inertia) and is remarkable for rotating uniformly throughout the (so-called) critical torque free motion (of a rigid body), regardless of whether the body "flips" (as Dzhanibekov observed) or maintains permanent rotation!

We shall support our presentation with clarifying computer animations, obtained by a mathematical modeling scientific team at the Department of Theoretical Mechanics of the Ural Federal University: Svetlana A. Berestova, Natalia E. Misura, Euigene A. Mityushov.

Alexey R. Alimov, E.V. Shchepin

Convexity of suns and Chebyshev sets in tangent directions

A direction d is called a tangent direction to the unit sphere S if the conditions $s \in S$ and $\operatorname{aff}(s+d)$ is a tangent line to the sphere S at s imply that $\operatorname{aff}(s+d)$ is a one-sided tangent to the sphere S, i.e., it is the limit of secant lines at the point s. A set M is called convex with respect to a direction d if $[x, y] \subset M$ whenever $x, y \in M$, $(y-x) \parallel d$. It is shown that in an arbitrary normed space an arbitrary sun (in particular, a boundedly compact Chebyshev set) is convex with respect to any tangent direction of the unit sphere.