

Astromathematics

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Fig. 1. Prof. Dr. Syed Arif Kamal giving seminar entitled ‘Astromathematics’ on April 15, 2014

‘Astromathematics’ was mentioned for the first time by the speaker <https://www.ngds-ku.org/Presentations/ISPA.pdf> on Monday, October 8, 2012, during the *First National Conference on Space Sciences*. It is a branch of mathematics, which focuses on geometrical aspects to study orbits from a kinematical perspective, in which the force expressions do not appear explicitly, but expressed as space-time-curvature equivalents. This formulation is capable of dealing with accelerated frames, governed by ‘geometroynamics’

<https://www.ngds-ku.org/Presentations/GenRelGrav.pdf> which is based on general theory of relativity

<https://www.ngds-ku.org/Presentations/Ghori.pdf> put forward in 1915. On March 20 of this year, the speaker delivered opening lecture of the *Second Conference on Mathematical Sciences (CMS 2014)*, entitled ‘Astromathematics: A New Branch of Mathematics’

<https://www.ngds-ku.org/Presentations/Astromathematics.pdf> ‘Astronomy’ is a discipline of natural science, which deals with

celestial objects. Astronomical models are mental pictures based on geometric ideas (outlines visual framework of model), physical concepts (deals with the motions and the interactions of various parts the model), aesthetic notions (innate judgments of what seems beautiful) and basic assumptions that explain current observations and predict future observations, while verifiable by a variety of observations changeable to match observations better. Babylonians, Greeks, Chinese and Muslims all had their contributions to astronomy, which was given elegance by the monumental contributions of Galileo, Kepler and Newton. ‘Astrodynamics’, introduced by Samuel Herrick (1911-1974), is considered a branch of mathematics, which deals with calculating orbits to reach a given planet. Richard H. Battin remarks in the preface to his book, *An Introduction to the Mathematics and (the) Methods of Astrodynamics* (Revised Edition), “In the three centuries following Kepler and Newton, the world’s greatest mathematicians brought, celestial mechanics to such an elegant state of maturity that, for several decades preceding the USSR’s Sputnik in 1957, it all but disappeared from the university curriculum.” The speaker got a chance to study thoroughly First Edition (1987) of this book. A review was prepared <https://www.ngds-ku.org/Papers/Battin.pdf> and sent to the author on July 19, 1993, who answered on October 25, 1993, “Thank you very much for your letter and your interest in my book. I appreciate your list of corrections and suggestions.” Sadly, Dr. Battin passed away on February 8 of this year and the speaker delivered Richard H. Battin memorial lecture <https://www.ngds-ku.org/Presentations/ExtendedQ.pdf> during CMS 2014. When the speaker joined University of Karachi in 1995, he taught Astronomy, Astrodynamics and Space-Flight Dynamics as well as conducted professional training courses at SUPARCO and Institute of Space Technology, realizing that the plane-polar coördinates are not the natural choice <https://www.ngds-ku.org/Presentations/Astrodynamic.pdf> for setting up two-body problem. Strong Noether’s Theorem <https://www.ngds-ku.org/Presentations/Noether.pdf> was formulated, which states that if one sets up a problem close to natural symmetries of the system, one discovers additional constants-of-motion. In this spirit, planetary orbits were modeled using the elliptic-astrodynamical-coördinate mesh <https://www.ngds-ku.org/Presentations/Planetary.pdf> that yielded 3 constants of motion. In addition, two-body problem has been formulated in the hyperbolic-astrodynamical-coördinate mesh <https://www.ngds-ku.org/Presentations/Hyperbolic.pdf> and new control laws devised: the extended-cross-product steering, the normal-component-cross-product steering <https://www.ngds-ku.org/Papers/C56.pdf> as well as the dot-product steering, the normal-component-dot-product steering <https://www.ngds-ku.org/Papers/C55.pdf> and the ellipse-orientation steering <https://www.ngds-ku.org/Presentations/Ellipse.pdf> — cross-range-error correction was integrated in the Lambert scheme <https://www.ngds-ku.org/Papers/C67.pdf> as well as the multistage- and the inverse-Lambert schemes proposed <https://www.ngds-ku.org/Papers/C72.pdf> for course-plotting a satellite-launch vehicle. Further, the multistage and the inverse-Q systems <https://www.ngds-ku.org/Papers/C66.pdf> were devised for steering a satellite-launch vehicle.

Keywords: Dot-product steering • Ellipse-orientation steering • Elliptic- and hyperbolic-astrodynamical-coördinate meshes • Extended-cross-product steering • Multistage-, inverse- and extended-Q systems • Multistage- and inverse-Lambert schemes • Strong Noether’s theorem • Two-body problem

Web address of this document: <https://www.ngds-ku.org/Presentations/Astromathematics14.pdf>

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