Astromathematics: A New Branch of Mathematics

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Fig. 1. Prof. Dr. Syed Arif Kamal delivering opening lecture of CMS 2014 on March 20, 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 'geometrodynamics'

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. '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 study thoroughly First Edition (1987) of this book. On July 19, 1993, he prepared a review and sent to the author https://www.ngds-ku.org/Papers/Battin.pdf 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." 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 https://www.ngds-ku.org/pub/confabst.htm#C60: are not the natural choice for setting up two-body problem. Strong Noether's Theorem https://www.ngds-ku.org/pub/confabst.htm#C61: 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/pub/confabst0.htm#C45: 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 that is going to be presented this afternoon. New control laws were devised — the extended-cross-product https://www.ngds-ku.org/Papers/C56.pdf steering, the normal-component-cross-product steering, the dot-product https://www.ngds-ku.org/Papers/C55.pdf steering, the normal-component-dot-product steering and the ellipse-orientation https://www.ngds-ku.org/pub/confabst.htm#C64: steering. Cross-range-error correction was integrated in the Lambert scheme https://www.ngds-ku.org/Papers/C67.pdf as well as the multi-stage- and the inverse-Lambert schemes proposed https://www.ngds-ku.org/Papers/C72.pdf for course-plotting a satellite-launch vehicle. In addition, the multi-stage and the inverse-Q systems were devised for steering a satellite-launch vehicle https://www.ngds-ku.org/Papers/C66.pdf

Keywords: Two-body problem, strong Noether's theorem, elliptic-astrodynamical-coördinate mesh, multi-stage- and inverse-Lambert schemes, multi-stage- and inverse-Q systems, extended-cross-product steering, dot-product steering, ellipse-orientation steering

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