Keynote Lecture to be delivered during *the Sixth UW-POF Conference on Academia's Collaboration with Industrial Organizations*, University of Wah, Wah, Pakistan, December 16, 2026 (Wednesday, December 16, 2026, 1000h-1030h, Auditorium, University of Wah), Inaugural Session, p 1

The Evolution of Astromathematics: A Journey of 14 *Years* (2012-2026)

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Astromathematics focuses on geometry to study orbits from a kinematical perspective. This branch of mathematics was introduced by the speaker on October 8, 2012 (Fig. 1) during the First National Conference on Space Sciences (NCSS 2012). In contrast to *astrodynamics*, the force expressions do not, explicitly, appear in the formulation of astromathamatics. Even if there appears a need to study force interactions, these are expressed as space-time-curvature equivalents. This formulation seems to be, generically, more suitable for accelerated frames governed by *geometro-dynamics*. This keynote lecture shall cover the evolution of astro-mathematics during the last 13 *years*. With space entrepreneurship as the focus of the current technological era, this lecture should emphasize the importance of developing commercial satellite-launching sites in Pakistan, which has the unique advantage of being near the equatorial circle, hence offering saving in fuel consumption as the velocity of earth rotation is added up in the velocity of satellites to be launched. The speaker worked in developing these technologies indigenously, in particular, explicit-guidance schemes (for a spacecraft approaching a destination, explicit-guidance scheme draws a path containing the current position of spacecraft, destination and center-of-earth in order to compute velocity vectors required to achieve the destination during the remaining transfer time) for satellite-launch vehicles, *viz.* the Lambert scheme with cross-range error included, the multistage-Lambert scheme, the inverse-Lambert scheme, the multistage-Q system, the inverse-Q system as well as the extended-Q system, through a deep study of astrodynamics and space-flight dynamics (the speaker was able to point out and to communicate mistakes in Richard H. Battin's classic on the subject, who, very kindly, acknowledged them in his letter). Cross-product steering, put forward by Battin, was incomplete and needed an additional condition. This condition was added by the speaker and the new control law (a control law is a relation, which is implemented on the original system to make it perform according to predecided standards) was termed as the extended-cross-product steering, which was later adapted for the normal-component-cross-product steering. Further, the dot-product steering and the normal-component-dot-product steering were formulated (if the components of velocity perpendicular and normal to the desired orbit are made to vanish, the spacecraft shall remain in that orbit unless there is a perturbation applied) and, finally, the ellipse-orientation steering. Two-body problem in the elliptic-astrodynamical-coördinate mesh, reducing the degrees-of-freedom from 12 to 1 (Fig. 2) as well as the hyperbolic-astrodynamical-coördinate mesh has, already, been set up. Control laws, (extended-cross-product steering and dot-product steering) were expressed in the hyperbolic-astrodynamical-coördinate mesh. *Air-Spacecrafts of the Third Millennium*, traveling on the elliptical trajectory, ASTM 786-E, was proposed on May 11, 2010, and the one traveling on the hyperbolic trajectory, ASTM 786-H, was proposed on October 16, 2025. Later, VTOHL (vertical take-off and hovercraft-landing), stealth and pilotless modes were added as well as GPS navigation replaced by INS navigation to prevent ASTM 786-H-M from EMP attacks and GPS-signal blocking/blinding. Additional security shall be available by establishing an encrypted communication system among crew and technicians onboard. Recently, nuclear-weapon-carrying capability as well as MIRV capability was added to the system. Further contributions include computation of down-range and cross-range errors for SRBMs. Future challenges of astromathematics include formulating the two-body problem in the parabolic-astrodynamical-coördinate mesh. This should be followed by writing control laws and working out explicit-guidance schemes in both the hyperbolic- and the parabolic-astrodynamical-coördinate meshes. In addition, SLVs (satellite-launch vehicles), based on these explicit-guidance schemes, should be designed to neutralize satellites implementing SDI (Strategic-Defense Initiative), which could, also, be used as an offensive weapon.

Fig. 1. Introducing 'astromathematics' during an invited lecture delivered in 2012

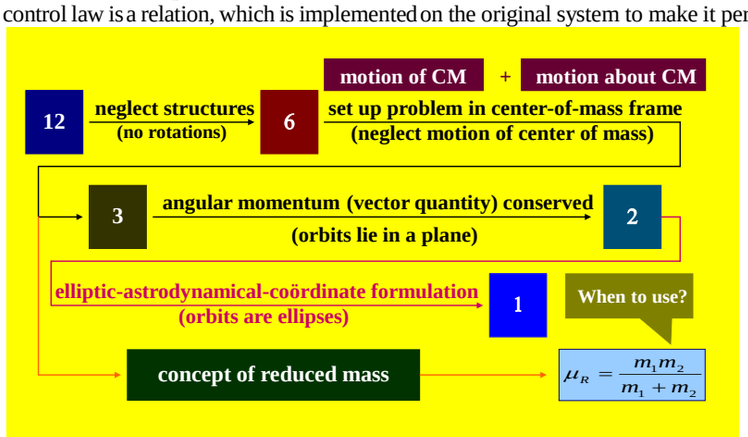

Fig. 2. Reduction of degrees-of-freedom for two-body problem set up in the elliptic-astrodynamical-coördinate mesh

Keywords: Astrodynamics • Control laws • Down-range and cross-range errors • Explicit-guidance schemes • Orbit theory • Satellite-launch vehicle • Space-flight dynamics Power-Point-Show Slides • Video-Recorded Presentation

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