



The Evolution of Astromathematics: A Journey of 13 Years (2012-2025)

Meritorious Professor Dr. Syed Arif Kamal[‡] profdrakamal@gmail.com

PhD; MA (Astrophysics), Johns Hopkins; MS (Gravitation Physics), Indiana; MSc, summa cum laude (Theoretical Physics, special courses in Space Physics), Ex-Acting Vice Chancellor and Ex-Dean, Faculties of Science & Engg., University of Karachi, PO Box No. 8423, Karachi 75270, Pakistan — Visiting Faculty, IST, Islamabad, Consultant, GNC Labs.* & Ex-SSO, Control-Systems Labs., SUPARCO (Plant)

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 *astromathematics*. 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 *astromathematics* 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 pre-decided standards) was



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

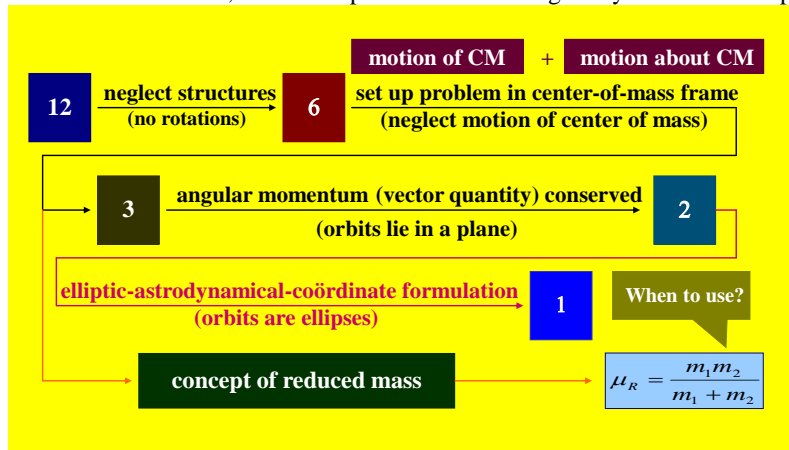


Fig. 2. Reduction of degrees-of-freedom for two-body problem set up in the elliptic-astrodynamical-coördinate mesh

hyperbolic-astrodynamical-coördinate mesh. *Air-Spacecrafts of the Third Millennium*, traveling on the elliptical trajectory, ASTM 786-E, was proposed in 2010, and the one traveling on the hyperbolic trajectory, ASTM 786-H, was proposed in October of this year. 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 GP-signal blocking/blinding. Recently, nuclear-weapon-carrying capability was added to the system. Further contributions include computation of down-range and down-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 guidance schemes in these coördinate meshes.

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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[‡]**Highest security clearance** by virtue of service in Pakistan Space and Upper Atmosphere Research Commission • Throughout First Class First Position (100% marks in all subjects in the final semester of MSc) • Listed in "Marquis' Who's Who in the World" and "Dictionary of International Biography" • Referee of "Astrophysics & Space Science" • Current affiliation: Department of Physics, University of Karachi • Institutional e-mail: sakamal@uok.edu.pk

*Guidance, Navigation and Control Laboratories, Pakistan Space and Upper Atmosphere Research Commission