The mathematician in Asutosh Mukhopadhyay

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During the 19 century, undivided Bengal had seen the ushering in of many stalwarts in the field of literature, art, science, philosophy, so much so that the said period is referred to as the Bengal Renaissance. Asutosh Mukhopadhyay was one among them. He was born on 29 June 1864 at Bhawanipur, Calcutta (now Kolkata), *thus making the current year his 150th birth anniversary*. He was an eminent educationist who served as many as four terms (1906–1914 and 1921–1923) as the Vice Chancellor of the University of Calcutta. Under his able guidance, the University of Calcutta got transformed from a merely examining body to one of the greatest teaching universities in the East.

Mukhopadhyay was also an eminent jurist who became a judge of the Calcutta High Court. He was indeed a versatile genius but his passion was mathematics. He did his M A in Pure and Applied Mathematics in 1885 and in the next year he completed the same in Physical Science. In 1886, he was awarded the Premchand Roychand Fellowship in Mathematics, Pure and Applied Physics.

Although his contribution as an educational administrator is highly recognized, he was a mathematician par excellence. His works have been recognized globally, particularly in the context of contributions made by Gaspare Mainardi, an Italian mathematician; Gaspard Monge, a French mathematician; George Boole, an English mathematician and others. For his outstanding contribution Asuthosh was elected Fellows of Royal Society of Edinburgh (1886), Royal Astronomical Society, the Soceite de Phisique of France, the Mathematical Society of Palermo (1890) and Members of the Mathematical Societies of London, Paris, Palermo and New York[1]. Asutosh is considered as the first Indian Mathematician after Bhaskara to enter the field of mathematical research[2]. His brilliance in mathematics could not get nurtured to the desired extent primarily due to lack of support from the colonial regime. Destiny made him pursue a career in law. Let us have a glimpse of Asutosh's contribution to mathematics.

On the differential equation of a trajectory

The problem of determining the oblique trajectory of a system of confocal ellipses, appears to have been solved first by the Italian mathematician, Mainardi[3]. His solution has been summarized in the form of two equations which are complicated and it was felt that it would be a difficult task to obtain the trace of the curve, i.e. the trajectory from it. Mukhopadhyay applied two simple substitutions and could obtain, two equations wherein x and y have got related in a symmetrical form to half the distance between the two foci and the tangent of the angle of intersection.

On the basis of Mainardi's problem, Mukhopadhyay worked out interesting derivations and also arrived at many crucial interpretations, conspicuous among them being the following:

- Interpretations of special cases pertaining to the intercept form of the equation of a straight line.
- The co-ordinates of the point of intersection of the two straight lines given by the general equation in x and y of the second degree.
- Area of the triangle formed by any line with the two lines given by the general equation.
- Meaning attributed to the constants in the equation of a circle.
- Equations of chords of a circle or a conic and those of tangents drawn to them.
- Transformation of the general equation of the second degree in x and y (of a conic) and introduction to the asymptotic constants.
- Reduction of the general equation to the asymptotes as co-ordinate axes.
- Identification of the invariants and covariants of a single conic.
- The Director Circle in rectangular and oblique co-ordinate axes.

Asutosh Mukhopadhyay

Mukhopadhyay made important contributions to Monge's work[4] on 'General differential equation to all conics'. Starting from the general equation of second degree in x and y which represents a conic (that is a parabola, ellipse, hyperbola or a pair of straight lines), Monge arrived at a fifth order nine-degree differential equation. The equation was made general but the corresponding geometrical interpretation became complicated. Mukhopadhyay used analytical method to simplify the interpretations and these have stood the test of time.

Significance of Mukhopadhyay's works

Instead of elaborating on the works of Mukhopadhyay which, I am afraid, would involve the use of many technical terms contrary to the spirit of a popular article, I will briefly mention the essence of the works of Mukhopadhyay. René Descartes is called the father of Co-ordinate Geometry, which is also called Analytical Geometry. It is so because, here rather than using traces and figures to do geometry, one uses algebraic methods. In a way co-ordinate geometry unifies algebra and geometry.

Similarly, Mukhopadhyay's concern was to arrive at a unification of analytical geometry and calculus. He believed in the dictum that 'Nature is unique'. When it comes to explanation of nature through mathematics the manifestations can be algebra, geometry, calculus, etc., but the natural laws would remain the same.

Concluding remarks

India has a tradition in mathematics. We have in our ranks exceptionally brilliant mathematicians like Aryabhatta, who had hinted towards the heliocentric model of the Solar System much before the Copernican revolution; Sridharacharya provided the method of solution of quadratic equations; Brahmagupta was the first to give rules to compute with zero; Varahmihir whose work is a treatise on mathematical astronomy which summarizes five earlier mathematical treatises; Bhaskaracharya was head of an astronomical observatory in Ujjain in the 12th century, which was the most important centre of mathematics in medieval India. In modern times we have Srinivasa Ramanujan, Dattaray Ramchandra Kaprekar and to that list we must not forget to add the name of Asutosh Mukhopadhyay who was not only an institution builder but a great creator of knowledge of mathematics.

1. Chittabrata, P. and Das, A., *Asutosh Mookerjee: Mathesis of Mathematics*, National Science Series, Readers Service, Kolkata, 2010, pp. 1–5.
2. Mookerjee, S. P., *Asutosh Mookerjee in Representative Indian* (eds Chatterjee, L. M. and Mookerjee, S. P.), Calcutta, 1931, p. 99.
3. Mukhopadhyay, A., *The Differential Equation of a Trajectory* – Communicated by Mahendralal Sircar, as in Op. cit 1. pp. 54–67.
4. *Ibid*, pp. 76–157.

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