

Wings of Fire

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Wings of Fire
A P J Abdul Kalam
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The book *Wings of Fire*, the autobiography of A P J Abdul Kalam constitutes an extraordinary reading for the young and old, for a common man and a professional including management pundits, and for the uninitiated and the technically trained alike. There is something that everybody can extract from this book. Only the very young readers of *Resonance* may find it beyond them.

The writing style is very gripping, and the contents are very unusual in their frankness at several levels while not being caustic or cynical and provide a brief panoramic view of the space and missile technology arena of the country. Books of this kind are very rare in our country; and we are prone to idolize and eulogize scientists and other personalities with individual excellence with almost no appreciation for the milieu in which creativity is possible. We are also hesitant to record truth, if we take interest in recording at all. The book is the story of a man who did not quite acquire 'power' by climbing through academic corridors, an approach with all its penchant for placing or replacing idols in its own sanctum-sanctorum of the academies or other positions is practised assiduously in the country. Even in the absence of this power

(or, is it because of its absence), he wove together large number of groups, challenged them to do the 'impossible', promoted them to work towards a common goal, and through successes, raised their self esteem enormously.

Apart from the very indicative title, the chapters of the book are also touching –orientation, creation, propitiation, and contemplation. Orientation contains 32 years of his early life – days as a child, going through adolescence and getting into rocketry. His description of the people who shaped his life, interweaving religion and education, is a charming part of the book that almost nobody would miss reading. One is reminded of R K Narayan while flipping through the text. The difficulties involved in getting education are very reminiscent of the era – the late thirties through the forties – which is full of examples of people of lower middle class (to which most of the society belonged) living largely in villages struggling hard to get education in cities/large towns with little infrastructure and financial support. Many in the current era of significant urbanization may not even be able to visualize the trauma that the generation of those times went through. The first chapter captures it succinctly.

Chapter 2 entitled 'Creation' describing the next seventeen years till 1980 covers his struggle at ISRO going from one-engineer-amongst-many to the successful project director of SLV bringing pride to the nation through the technological achievement of putting a satellite in the orbit. He forgets not recording the contributions of the many – both high profile as well the brave backroom 'boys'. There are several



technological aspects discussed here and these would interest the technically minded a great deal. The description of Sarabhai, the early leader for space technology, his vision, mode of working is historically important. Kalam's choice as the Project Director by Dhawan as Chairman, ISRO and Brahm Prakash as Director, VSSC has been left unexplained, but perhaps may not require one; they saw in him qualities of bringing together others and getting things done with least interpersonal pain while all the time thinking of possible problem areas requiring attention. His agony when the first SLV flight failed to reach the orbit and the maturity of the management in retaining him in the same position are brought out. There are several attractive observations, poems and personal details of his family interspersed between the hard technical descriptions that keep the reader glued to the book. This chapter ends in the description of his transition from ISRO to DRDO as the next director of DRDL.

The next ten years are set out in chapter 3. These constitute the outstanding accomplishments at DRDL. The way he transformed the laboratory from one which had a weak heart with little confidence to one which felt a sense of strong self-esteem and could feel proud by contributing developed missile systems to the services, is a remarkable saga. The methods by which he accomplished this were three. First, generate first rate technologically contemporary projects and hold them as challenges to the technical community. Second, bring together academics and scientists from R & D institutions for reviews, a

somewhat scandalizing event in tradition bound defence laboratories. Third, hold a fair number of internal meetings with members drawn from different projects and disciplines so that latent difficult issues come up for discussion and learning from one another was caused. The methodology that he adopted here was drawn from his earlier experience in ISRO.

On page 122 in this chapter, he discusses the logic for the choice of the Project Directors for the five integrated guided missile development projects (all of these were his masterly creation). The three paragraphs provide an insightful reading even for a management man, coming as it were from a successful leader. His remarks on TN Seshan (the well-known retired Chief Election Commissioner) are so apt that nobody would disagree. The fact that the book carries several truthful asides like this on personalities known to many including the present reviewer makes it authentic and worthy of reading.

Kalam has pet themes – one of these is the fact that unless we become strong there is no likelihood of us being respected as a super power (in today's terminology, a country which holds the ability to destroy some other country from a distance). He has used the phrase "strength respects strength" several times in his lectures. This assessment is indeed correct. The second theme is that India should become a developed nation. In fact, the last sentence of the book is along these lines. The plan to make India an economically strong nation is vital for India to be rated well along with the



super powers. For this to happen, many other aspects – the enormous moral decadence leading to corruption in higher levels of society, the inability to prevent this from affecting the common man’s life, the inability to improve the quality of life of 70% of the population residing in the villages, the inability to reduce the pace of urbanization and the inability to reduce the inequity between the rich and the poor need to be accounted for. These are of course beyond the preview of one worthy citizen whose life is described in this book.

The last chapter entitled ‘Contemplation’ contains a condensation of ideas and thoughts arising out of his colourful life, the awards that

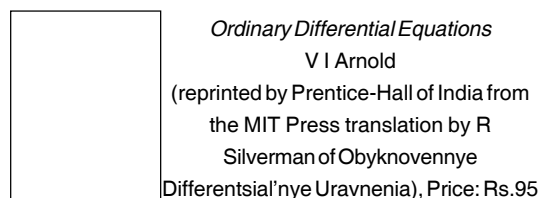
he received (the highest honour, namely Bharata Ratna that he received does not find a mention in this book) and some messages for the future generation.

The book is worthy of being read by every Indian who can read!

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Ordinary Differential Equations

Shiva Shankar



“Space and time are commonly regarded as the forms of existence of the real world, matter as its substance. A definite portion of matter occupies a definite part of space at a definite moment of time. It is in the composite idea of motion that these three fundamental conceptions enter into intimate relationship”. So declared Hermann Weyl, and this declaration of the

supreme importance of the study of motion is at the same time also a declaration of the supreme position that the theory of differential equations holds in mathematics and physics. For, since Newton, it has been clear that the “shape of motion” is determined by local data, encapsulated in what we call a differential equation, and the study of motion is thus synonymous with the study of differential equations. But the shape of motion equally clearly depends on the global shape of (phase) space, and the study of differential equations must therefore be geometric in its methods. This geometric nature of the study of motion was of course clear to Newton (as even a superficial browsing of the *Principia* will confirm), but had to be reaffirmed by Poincaré after a 200 year interregnum, perhaps inevitable, during which time Lagrange could



even exult that he had banished figures from the study of mechanics!

The book under review is a first level text in the geometric spirit of Newton and Poincaré and contains 259 illuminating figures. But how is one to start such a study of differential equations? After all, people observed things in motion for many thousands of years before they realized that these trajectories were solutions to differential equations. Naturally then does Arnold start with the formal properties of solutions or phase curves, viz. the concept of a one-parameter group of diffeomorphisms of phase space. This is the collection of all solutions considered (and pictured in one's mind) as a single geometric object. The differential equation itself can then be pictured as a collection of vectors (arrows), at every point tangent to the phase curves (i.e. as a section of the tangent bundle, or a vector field). Thus given a differential equation (i.e. a vector field), to solve it is to fill up phase space with curves, all tangent to the vector field.

With this geometric picture in mind, understanding and progress come easy. One can visualize how the shape of a vector field must change under the action of a diffeomorphism (change of coordinates); one can even convince oneself (without the crutch of a formal proof) the validity of the 'basic theorem of the theory of ordinary differential equations', viz. that in some small neighbourhood of a nonsingular point (i.e. a point where the vector field does not vanish), one can by a diffeomorphism carry it to a constant vector

field. Even if the vector field vanishes at some point, one can by adding the equation $dt/dt=1$, reduce this situation to the one above. Local properties of the flow (existence, uniqueness, dependence on a parameter etc.) can now be easily deduced from the corresponding properties of the trivial constant vector field. A formal proof of this basic theorem, including a discussion on the contraction mapping principle and other related material, is collected in a separate chapter towards the end of the book – one therefore makes rapid progress simply assuming these statements.

Arnold then goes on to discuss in detail the important and transparent case of a one-parameter group of linear automorphisms of euclidean space, i.e. linear differential equations. Starting with the definition of the exponential of a linear map, he goes on to discuss topological conjugacy of linear hyperbolic systems, Lyapunov stability, nonautonomous systems, systems with periodic coefficients and a host of other topics. The book ends with a chapter on differential equations on manifolds, including a beautiful discussion (leading up to almost a proof) of the Hopf index theorem for a flavour of the topological nature of the global theory.

Let me illustrate the beauty and the simplicity of the geometric methods in Arnold's book by the following example. The problem is to solve the initial value problem for the nonhomogeneous linear equation

$$\frac{dx}{dt} = Ax + h(t), \quad x(t_0) = c,$$

where x is in \mathbb{R}^n and A is a linear map on \mathbb{R}^n . The method is the variation of constants, whose usual explanation of replacing constants with functions in the solution of the homogeneous equation always left me mystified. But consider Arnold's explanation: the solution of the homogeneous equation

$$\frac{dx}{dt} = Ax, \quad x(t_0) = c,$$

is $e^{tA}c$. Thus acting on \mathbb{R}^n at time t by the linear automorphism e^{-tA} moves this solution of the homogeneous equation to the constant curve c , i.e. to the solution of

$$\frac{dx}{dt} = 0, \quad x(t_0) = c.$$

As this is a linear change of coordinates, the derivative of this automorphism is again e^{-tA} . Under it the nonhomogeneous equation becomes

$$\frac{dx}{dt} = e^{-tA}h(t), \quad x(t_0) = c,$$

whose solution is clearly $x(t) = c + \int_{t_0}^t e^{-\tau A} h(\tau) d\tau$. Returning by the inverse of this automorphism, i.e. by e^{tA} , yields the solution of the original equation i.e. $e^{tA}c + \int_{t_0}^t e^{(t-\tau)A} h(\tau) d\tau$!! Can one praise enough this masterly book by a master mathematician? I cannot. I learnt the subject reading this book and I prescribe it even to engineering students (for courses on control). This is the definitive introductory book on ordinary differential equations; there is no need to read (or write) another.

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ANNOUNCEMENT

An instructional conference on Number Theory will be held at the University of Hyderabad during the period 1–21 December, 1999. The conference is sponsored by the National Board of Higher Mathematics (NBHM). The conference is meant for research scholars and college teachers interested in Algebra/Number Theory. The conference meets the requirements of a course for career advancement. TA/DA will be paid for most participants though research scholars who have fellowships are encouraged to use their contingency grants. Boarding and lodging expenses will be met for all selected participants by the NBHM.

The course will cover basic algebraic number theory and some applications. An attempt will be made to show how Fermat's Last Theorem motivated the development of the subject.

Applicants may apply on a plain sheet of paper giving the following information:

- 1) Name, 2) Age, 3) Address, 4) Sex, 5) Educational qualifications, 6) Present position, 7) Institution currently studying in or serving, 8) Two letters of recommendation, 9) whether accommodation is required (the university campus is about 15 km outside the city of Hyderabad), 10) Whether the applicant can bear his/her travel expenses, 11) Other information that may be useful to the organising committee. Applications must be sent to: Coordinator NBHM conference on Number Theory, Department of Mathematics and Statistics, University of Hyderabad, Hyderabad 500 046. The last date for submitting applications is 1–11–1999.

