Physics à la Russe

Reflections on Liquid Helium. E. L. ANDRONIKASHVILI. American Institute of Physics, New York, 1990. x, 317 pp., illus. $60. AIP Translation Series. Translated, with additions by the author, from the Russian edition (Tbilisi, 1980) by Robert Berman.

Discussing one of the many times he falls in love in this volume, Elevter Andronikashvili describes the young lady in question as "she, who shared with liquid helium the ability to make me enjoy myself." If this seems to you (as it does to me) a perfectly sensible way of describing the sensation of young love, then you probably should read this book.

The problem of superfluidity in liquid helium beguiled some of the world's best physicists. There was never the slightest hope of practical applications, or even that the solution to the problem would illuminate other areas of science. There was only the lure of the problem itself. Nevertheless, Landau, Feynman, Onsager, Kapitsa and Peshkov, Hall and Vinen, the Fairbanks brothers, Russell Donnelly (who wrote an introduction to this volume), and countless others of the best and the brightest all over the world were drawn inexorably into it. Andronikashvili certainly belongs in the pantheon of the heroes of helium, and that strange episode forms the backdrop of this highly personal, curious, and entertaining book.

In 1939, Andronikashvili was invited to spend a year—18 months at the most—at Petr Kapitsa's famous Institute of Physical Problems in Moscow. By the time he left in 1948 he had obtained his doctorate and performed the celebrated experiment that forced low-temperature physicists all over the world to learn to pronounce his name. In essence he proved the correctness of Lev Landau's two-fluid model, or, as he says, demonstrated the fact that superfluid helium could move and stand still at the same time.

The book is a collection of sketches, stories, and reminiscences that together form an intimate scientific and social autobiography of the life and times of a Soviet scientist. Somewhat along the lines of Heisenberg's *Physics and Beyond*, it makes frequent use of verbatim dialogue, reconstructing in detail conversations that took place as much as 50 years ago. The rather crude translation often adds to the charm of the volume by suggesting the original Russian rather than slick, colloquial English. Unfortunately, many stories and some scientific explanations seem to lose their meaning in translation. Figure out what this means, for example:

> I absolutely do not know when Landau worked. Only, what happened during those hours when he was closeted with Zhenya Lifshitz remained unobserved.

On the other hand, some exchanges are universal. Young Andronikashvili asks Kapitsa why the paper on what would become his famous experiment has not been sent off for publication. Kapitsa responds by asking why Andronikashvili went off to his native Tbilisi before presenting a seminar on the subject.

> "I had a cold, Petr Leonidovitch—"
> "Your cold, was it a blond or a brunette?"
> "More of a brunette."

Incidentally, Andronikashvili apparently remains a bachelor to this day.

The book spans a time, 1939 through the 1960s, when a number of interesting events took place in the Soviet Union and on the world scene. These events pass almost unnoticed, but we do read at length about other rivalries: Soviet versus Western science, Georgian versus Russian nationality, even a bit of Landau versus Feynman. It may be, however, that political commentary is present in a form more subtle than we Westerners are accustomed to reading. For example, not a word is said about why or how Kapitsa left Cambridge to set up his institute in Moscow. But we are told that, in 1948, Andronikashvili is virtually shanghaied, under orders of the Central Committee, to leave Moscow and return to his native Tbilisi, where he wins considerable fame and honor as the father of Georgian science. All of this bears a strong resemblance to Kapitsa's story.

Every now and then, we do get a glimpse of the political situation. At Landau's 50th birthday party, a deck of cards is presented. Landau is portrayed on all the aces and his wife, Kora, on the queens. The jacks are his students. The kings are his illustrious former students, all except one card with only a single picture. "The empty place was reserved for a scientist 'excommunicated from the church,' whose portrait the other students did not dare make." Nor does Andronikashvili, writing in 1980, tell us the name of the outcast.

Visiting England in 1958, he notes the meadows, gardens, and woods of the English countryside. "Fences and hedges separated these into squares of uneven sizes," he sniffs, "a distinctive reflection of private property." By this time, Andronikashvili is a Stalin Prize winner, director of the institute and head of the physics department at Tbilisi, academician of the Georgian Academy, and deputy of the Georgian Supreme Soviet. He has a maid and a chauffeur. He records that his host, Philip Sykes, a director of the vast firm British Oxygen, is obliged to have his own children clear the table. Later, visiting Scotland, he is sensitive to the Scots' resentment of the English. But, seeing the ruins of St. Andrews Cathedral, he compares it mentally to the much smaller Georgian monasteries and decides that Scotland was part of "a colonial power that got rich at the expense of other nations."

The book has in it a number of real howlers. Richard Feynman, we are told, was "a passionate hunter and fisherman." About equally likely, we also learn that Copernicus spent half his life in Poland and half in Scotland. My guess is that this last was planted by Jack Allen, discoverer, along with Meissner and Kapitsa, of superfluidity and Andronikashvili's host at St. Andrews. I can see Allen reading this book and rubbing his hands in glee. Alas, it is too late to find out for sure who planted the Feynman story.

The point is, what we read in this book is not necessarily what is true or accurate, but it is what Elevter Andronikashvili saw and thought. He is proud and chauvinistic, and he wins every scientific argument that comes his way. On the other hand, he is never mean-spirited, he never loses his sense of humor, and in the end we can't help liking him.

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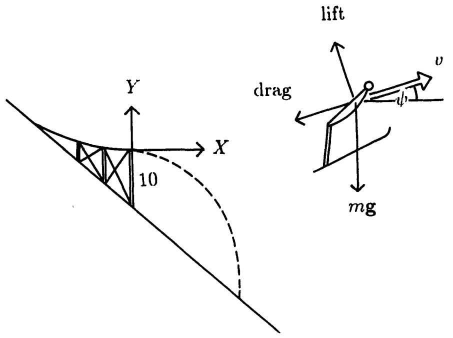
Equations of Sport

The Mathematics of Projectiles in Sport. NEVILLE DE MESTRE. Cambridge University Press, New York, 1990. xii, 175 pp., illus. Paper, $22.95. Australian Mathematical Society Lecture Series, vol. 6.

Physics students are traditionally introduced to the topic of projectile motion very early in the game, usually within the first few weeks of the freshman physics course. Typically, students are presented with a set of equations describing such quantities as velocity, time of flight, and horizontal range and are then assigned a set of homework



"Force diagram and jump profile for Nordic ski jump." The jumper "with his skis on has a mass of 70 kg, and his frontal area in the jumping position through the air is 0.7 m^2. At a certain jumping altitude the air density is 1.007 kg m^{-3} and the value of g is 9.81 ms^{-2}. If the drag and lift forces are proportional to the square of the speed with $C_D = 1.78$, $C_L = 0.44$ and if his velocity at the take-off point is 15 ms^{-1} in the horizontal direction, determine where he will land on the hill-slope whose angle is 45°. The take-off point is 10 metres vertically above the slope." [From *The Mathematics of Projectiles in Sport*]

problems involving the trajectories of various types of projectiles ranging from bombs to golf balls. Underlying all their calculations is a basic assumption: *air resistance can be neglected*.

Many years after I graduated, when I began to study the trajectories of sports projectiles, it came as something of a shock to me to discover that air resistance has a significant effect on the flight of almost any projectile. I felt considerable resentment toward my freshman physics instructor for not taking the trouble to mention this fact before we zipped along to the next chapter of Sears and Zemansky. In defense of this oversight, I should point out that when one does attempt to take air resistance realistically into account, the projectile motion equations turn out not to have analytic solutions, and must be solved numerically. My physics education took place in the days when we carried slide rules, rather than lap-top computers, to class every day.

Actually, the study of projectile motion through resisting media has a very long history. Contributions have been made by the likes of Galileo, Newton, Bernoulli, and Leibniz. However, work on this subject has, in the main, been in the service of the military; there is an extensive literature detailing methods for calculating the paths of cannonballs, bullets, artillery shells, and so on.

It is therefore a pleasure to report that the latest text in this line, *The Mathematics of Projectiles in Sport*, focuses the power of mathematics on the study of sports projectiles rather than on ways to destroy other human beings more efficiently. Its author, Australian mathematician Neville de Mestre, formerly of the Australian Defense Force Academy, now teaches at Bond University in Queensland. His stated aim is "to present a unified collection of the many problems that can be solved and of all the mathematical techniques that can be employed. . . . Emphasis here will be on the non-military applications of the behaviour of projectiles in flight, which have received only limited attention." De Mestre's aims are indeed admirable, and the work itself deserves considerable praise. This is a very readable, informative, and entertaining text, and its publication coincides most appropriately with the end of the Cold War.

As the title clearly states, this is a mathematics text; it is written for a reader who is comfortable with differential equations. The author begins by deriving in their most general forms the equations for projectile motion under gravity alone and then proceeds in an orderly fashion to the cases of linear drag (which lends itself to analytical solution, but has virtually no practical applications) and quadratic drag (which represents most aerodynamic forces, but must be solved numerically). Various approximation techniques are presented, and the effects of such factors as the Coriolis force, wind, density variations, and spin are also discussed. De Mestre's approach is to develop the mathematics up to the point where numerical integration becomes necessary, whereupon he leaves it to the reader to devise the numerical methods.

The development proceeds in a succinct, lively manner, with real-world references presented wherever possible. A particularly helpful touch is the inclusion of solved problems in the text, in addition to a set of exercises for the reader at the end of each chapter.

The last chapter of the book deals with specific applications to a wide range of sports projectiles. These have a distinctly Australian flavor; there are more references to rugby, soccer, and cricket than to American football or baseball (it was interesting to learn that whereas an American football is spiralled, a rugby football is torpedoed). There is also a solved problem on the jumping distance of a kangaroo (p. 83) as well as an exercise on a gumboot throwing contest, whatever that is (p. 76).

In short, anyone who does projectile motion calculations will be extremely pleased by de Mestre's efforts. Ten years ago, when I set out to write a computer code to calculate baseball trajectories, I spent a lot of time plowing through obscure journals and texts trying to glean information on solution techniques from a rather disjointed literature. I wish de Mestre's book had been around then; it would have been of enormous help. But I suspect that at that time it probably would have had more references to bullets than to baseballs.

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Stellar Dynamics

Dynamics of Dense Stellar Systems. DAVID MERRITT, Ed. Cambridge University Press, New York, 1989. xii, 251 pp., illus. $49.50. From a workshop, Toronto, Ontario, May 1988.

This book offers a long-needed survey on the kinematics and dynamics of the central—and densest—parts of galaxies and globular clusters. Although the structure of those objects has been a subject of detailed study for a long time, reliable results have only recently begun to appear. There are several reasons why dense stellar systems attract a lot of attention. First, they have comparatively short relaxation times, which makes them ideal objects for checking different theories of dynamics and evolution of stellar systems. Second, the central parts of dense stellar systems form a stage where various forms of activity are played out. And finally, it would not be an exaggeration to say that, among the reasons that astronomers and physicists are so enthusiastic about dense stellar systems, one is especially tantalizing: the evolution of these systems seems to be a natural way to the formation of massive or even supermassive black holes. Indeed, it was the discussions related to this topic that I found most interesting in *Dynamics of Dense Stellar Systems*.

Some important differences should exist between the evolution of globular clusters and galactic nuclei, and, in fact, available data on x-ray sources in globulars has demonstrated that they do not contain black holes—at least, not very massive ones (although in the mid-1970s there was a widespread belief that some of them did). Meanwhile, nuclear star clusters in normal galaxies, not to mention active galactic nuclei and quasars, seem to be ideal sites for harboring supermassive black holes of 10^6 to 10^9 solar masses.

A supermassive black hole within the nuclear star cluster of a normal galaxy can be disclosed by an increase of two important values—mass-to-luminosity ratio and stellar velocity dispersion—toward the galactic center. Unfortunately, evidence of this kind is not unambiguous. Even if the stellar distribution around the center is isotropic, the presence of another stellar population