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REVIEWS

Rossby Vortices, Spiral Structures, Solitons. By M. V. NEZLIN and E. N. SNEZHKIN, Springer, 1993. 223 pp. DM 128.

Galaxies are great agglomerations of stars and dust. They come in various types: there are ellipticals, which contain little gas and look homogeneous and lifeless, like great stranded whales. There are also disk galaxies which do contain appreciable amounts of gas and are highly structured. They have spiral arms, which clearly must have been formed by a dynamical process. The gas never constitutes a large fraction of the mass, less than about 10%, even in these galaxies. However, new and bright stars can condense from the gas when it settles into a thin rotating disk, and then contracts into the molecular clouds where the stars are born. A new star, with mass 30 $M_\odot$ say, will outshine a million old stars, each with mass 0.5 $M_\odot$. No wonder that disk galaxies tend to be more eye-catching than ellipticals. The bright stars are usually located in spiral arms, and it is clearly important to discover the dynamical process that forms the spiral structures.

There is a real difficulty, though; even with the best equipment available it would take an observer at least 10000 years before he could detect even the slightest signal indicating any transverse motion in the spiral arms of the Andromeda Nebula. Other galaxies are much further away. So how to deal with the dynamics of objects that will not move significantly in a human lifetime?

Nezhin and Snezhkin (N & S for short) have developed an ingenious apparatus to do just that, which can also help solve other problems in astrophysics and plasma physics. Their device is simple: a bowl-like structure with axial symmetry, into which a layer of water can be introduced. The bottom of the bowl is formed by many rings, which can be rotated independently. The water above a ring rotates with the ring and the shape of the bowl is such that the fluid tends to form a layer of uniform thickness under gravity and centrifugal force, though this equilibrium may well be unstable. The apparatus gives N & S much scope for investigating interesting wave motions.

Any astrophysicist who has read this far will probably throw up his hands in horror. What can a piece of plumbing like this tell us about a great galaxy full of stars embedded in a multi-phase gaseous medium, laced by magnetic fields and containing cosmic rays? But this is just where N & S show their superior insight. In the last resort the significant aspects of the dynamics of a system do not lie in the particular set of substances that it happens to consist of. It is much more relevant to investigate the properties of the wave-like disturbances that the system can support. N & S are especially fond of solitons and describe the necessary conditions for them to exist (decreasing group velocity with increasing wavenumber). Such conditions will also apply in any galactic disc which is close to marginal stability, its normal state, and so we should see that there is a good analogy between solitons and spiral arms. Perhaps this realization will bridge the gap between those stellar dynamists who believe that spirals are structures with a grand design that endures, and those who argue that spiral arms are the transient results of an instability.

In chapter 7 of the book N & S apply their ideas to the Great Red Spot of Jupiter, obviously a long-lasting soliton in their view. But where did it originally come from? Did the hand of God, sometime in the past, dip a finger into the Jovian atmosphere and then pull it out again, leaving a large-scale vortex that is still swirling? Well, no,

but this year (in July 1994) a perfectly natural event will occur and will mimic such divine interference; twenty or so separate pieces of the Comet Shoemaker–Levy 9 will fall into the Jovian atmosphere. I wonder whether a second red spot will form subsequently, and how N&S will simulate this strange accident.

F. D. KAHN

Biofluid Mechanics. By J. N. MAZUMDAR. World Scientific, 1992. 191 pp. $35.

Despite its title, this book is almost entirely concerned with blood flow and the human circulatory system. The stated intention is to provide more biological background than is usually found in textbooks for final-year undergraduates or beginning postgraduates in engineering or applied mathematics. Disappointingly, although there are useful introductions to topics of clinical importance, the author repeatedly fails to make any satisfactory connections with the mathematical content of the book, and the reader is left frustrated by the absence of comparisons with experimental or clinical data.

The first three chapters consist of brief introductions to the equations of fluid mechanics, the circulatory system, the rheology of blood and the anatomy of blood-vessel walls. The substantial fourth chapter deals with steady laminar flow and sinusoidal flow in an elastic-walled tube, and includes an approximate analysis of the flow over a stenosis, based on an assumption of plug flow through the constriction. This is followed by a chapter on non-Newtonian fluids and steady flows of such fluids through elastic tubes. A simple model of the advection and diffusion of a passive tracer in steady flow, with applications to the transport of oxygen and to haemodialysis, is considered in chapter 6, together with a short section on peristalsis. There is an abrupt change away from simple analytical models in the final two chapters, which begin with a fairly lengthy discussion of the clinical problems associated with artificial heart valves, and move on to a detailed description of a computational fluid dynamics code for steady flow through constricted channels at Reynolds numbers up to 4000.

Overall, the absence of any discussion of the strengths and weaknesses of the mathematical models, which is essential in this subject, the imbalance between simple analysis and detailed computational fluid dynamics, and occasional mathematical weaknesses (such as misdefining stress vectors and glossing over difficult rationalizations of approximations) make this a book that I would recommend only for background reading.

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