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I was quite disconcerted to see that my last post had been at the end of July, just before I took my summer break. However, I've been busy planning a new book on the phenomenology of isotropic turbulence. This term now seems to be in quite general use, extending back over the last couple of decades, so it would be worth considering what exactly it means.

If we go back to sources, phenomenology seems to have originated in mathematics and then been taken over by philosophy. It appears to have found its main applications in philosophy and sociology. A basic characteristic is that it is an activity which avoids theorising or attempting to explain. That is, it is an attitude of mind adopted when investigating a field in which one is content to describe the field without attempting to explain it. This actually is a good way of approaching any new investigation. We need to establish the facts, uncontaminated by speculation or even emotional reactions. Such attitudes must underpin any effective legal-judicial system.

My impression is that nowadays in physics what is called phenomenology is in fact an attempt to explain things; largely because the traditional fundamental theoretical physics approach is too difficult. This seemed to me to be particularly so in particle physics, and I thought it appropriate to adopt it for turbulence. So, around the turn of the millennium, I began using it in that sense in turbulence. I also noted that others were using it, and I assumed that it was in the same sense. But this could be a dangerous assumption, so I was pleased to find out that the subject of this usage had been discussed in the book by the late Arkady

Tsinober [1], where it appears as chapter 5.

Tsinober quotes various views on the subject and one clear point that emerges is that in science and particularly turbulence it is regarded as an inferior activity and spoken of in a disparaging way. This is not surprising. Many turbulence researchers are applied mathematicians, whose ingrained approach is to solve mathematical equations subject to initial and boundary conditions. Unfortunately, the governing equations of turbulent motion are nonlinear and hence insoluble.

After pointing out that there is no definition of phenomenology of turbulent flows, Tsinober puts forward two views of his own. First, he suggests that it is a statement of impotence, consisting of everything but direct experimental results and any results that can be obtained from first principles. As an example of the latter, he cites the (presumably) derivation of the Navier-Stokes equations. At first sight this seems reasonable because to a physicist experiment provides the foundation of a subject. However, second thoughts suggest that the vast and diverse set of experimental results in turbulence are not really foundational in character. Thus, I would be inclined to class them as part of the phenomenology.

His second point of view is:

"*Phenomenology of turbulence involves use of dimensional analysis, a variety of scale arguments, symmetry, invariant properties, and various assumptions, some of which are of unknown validity and obscure physical and mathematical justification (if any).*"

I would agree with that. Broadly the motive for this activity is to increase understanding. Where I differ from him is his inclusion of semiempirical approaches and turbulence modelling and above all with his blurring of the distinction between theory and modelling. I will discuss this in my next post.

[1] A. Tsinober. An Informal Conceptual Introduction to Turbulence. Springer, Dordrecht, 2nd edition, 2009.