A Tribute to Jean-Pierre Vigier

Jean-Claude Pecker
College de France
Paris, France

Few of us have a mind as youthful, an imagination as fresh or an enthusiasm as contagious as Jean-Pierre Vigier, now seventy-years old. Knowing him as I do, I have no doubt he will retain his fiery spirit the rest of his life.

Ever since the bleak years of the second world war (when he fought courageously as an officer of the FTP), Jean-Pierre Vigier has been a fighter. During an active life on the political left, he made few friends and many enemies. As an active member of the Communist Party (until he was expelled!), he was among those who took an intransigent position against the French Vietnam war, against the Algerian war and against the powers that be, even within the party!

Because he opposed the powers that be in science with the same resolve and energy, his career in academia was far from what he had hoped for. The fact is that in our profession, discretion, reserve and prudence are often rewarded over a courageous defence of ideas that run counter to the scientific "establishment".

Early on in his career, Jean-Pierre Vigier met two figures who were to change the course of his work. For a time, he was assistant to

F. Joliot at the Collège de France. Then, later, as he began to question the very foundations of physics, he worked under the direction of Louis de Broglie, who had a profound influence on him. Without going into too much detail, I shall simply highlight a few key moments in this work in the fields of physics and astrophysics (the interested reader is referred to the proceedings of the symposium on "Quantum Non-Locality and the Global Structure of Space-Time" held in his honour at the Institut Henri Poincaré, *Annales IHP* **49**, 3, 1988, which covers all aspects of his scientific work).

A central theme of Jean-Pierre's work since 1951 has been the "pilot wave", i.e. the notion that every particle has a wave associated with it. But this idea, first put forward by de Broglie, can be interpreted according to the Copenhagen school or according to de Broglie (and with him, Einstein). In their view, the wave-particle duality, which is quite real, does not imply indeterminism at a fundamental level. In fact, a determinacy principle based on "hidden" variables can explain the wave and particle nature of matter, the wave acting as a guide for the particle. Needless to say, this idea has never been accepted. When Bell introduced his "inequalities", many thought it would be possible to decide between the Copenhagen interpretation and Vigier's "deep" determinism. Some experiments (*e.g.* Aspect's work) have been invoked to justify the Bohr-Heisenberg version of quantum mechanics, although it is my belief that this conclusion is mistaken. This is because what is at issue here is not the operational validity of quantum mechanics, but the interpretation. Does the particle (*e.g.* an electron, photon or neutron) have particle properties (in other words, is its location defined?) and wave properties *simultaneously*—and this is the position of de Broglie, Einstein, Bohm and... Vigier—or are these properties mutually *exclusive*? Experiments with photons are difficult: it is impossible to have a single photon in the apparatus at a time, while it is especially difficult to determine the path followed by particles. Experiments with neutrons, however, don't present this problem. The wave packet associated with a neutron is on the order of a few millimeters in length, and neutrons can be made to pass through a single-crystal interferometer one at a time. Rauch has been successful with this part of the experiment. The next question, once a single neutron has been introduced, is whether interference will be produced? In the pilot wave theory, where wave and particle coexist, interference is predicted. The Bohr-Heisenberg point of view predicts no interference. The experiment is being performed now.

No matter what the outcome (and I have reason to believe that Vigier will be proven right), Vigier's work has brought a solution to this fundamental question much closer. In a series of publications (including one with Karl Popper), he has examined all aspects of the EPR paradox, and proposed a variety of experiments to resolve the dilemma posed by both the article by Einstein, Podolsky and Rosen, and Bell's inequalities. Incidentally, contrary to the press reports after Bell's death, he was in favour of Vigier's interpretation—a contention which is borne out by his contribution to the 1987 Nobel Symposium in Stockholm. We impatiently await the results of Rauch's latest experiment.

If Vigier is right, the pilot wave theory imposes two conditions. First, all particles (neutrons and photons alike) have nonzero rest masses. And second, since the pilot wave is no longer a probability wave expressing the likelihood of the particle's presence, but a real wave, it must have a "support". And this support must be an ether, albeit a covariant one, as Dirac established some time ago.

These two complementary aspects of the physics of the pilot wave can only lead to directly observable effects where photons coming from distant sources, such as the sun or other galaxies, are involved. In the second part of his work, Vigier has therefore sought to analyze "abnormal" redshift effects as a tired-light phenomenon and interpret the tired-light mechanism as an interaction between photons and the space through which they travel. This conception further implies that the photon has a spatial extension, small perhaps, but enough to necessitate an original interpretation of the role of the light cone.

We embarked on this series of investigations back in 1971, even before Arp published his first papers on the subject, with an article signed by Vigier, myself and A.P. Roberts. Rejected by the journal *Astrophysical Letters* after a lengthy dispute between the authors, the editor and the referees, the article wasn't to appear until more than a year later (1972, *CRAcSC* **274B**, 765-). In the meantime Arp's discoveries of "abnormal redshifts" had been published. The idea was that, if they were indeed Doppler redshifts, they would impose unacceptable local velocities, and if they were not, distant galaxies could be affected more by them than by expansion effects. Hence the linear Hubble law could be interpreted—as Zwicky, Finlay-Freundlich and Max Born had done before—as a loss of photon energy in steps of $h\Delta\nu$, proportional to the distance travelled, i.e. as a tired-light effect.

We began looking for other examples in the Sun and objects occulted by the Sun, in double stars, where the Doppler interpretation was impossible. With our co-workers, we succeeded in identifying other effects, such as a pronounced periodicity in ln(1+z) for QSO-QSS histograms (with Depaquit), an extra redshift effect in light passing through clusters (with Karoji and Nottale), an extra redshift that occurs in blue galaxies in clusters (with S. Collin and H. Tovmassian), etc. All the data seemed to point to one conclusion. Yet our articles were misunderstood and given a cold reception. Based on an incorrect interpretation of what we said in our text (perhaps not as clearly as one would wish), Schatzman and Puget insisted that the so-called 3°K blackbody radiation could not result from secondary photons. We were told the images of distant objects should be blurred (true, but the problem is quantitative: a minimum distance has to be set). While convective motions in the Sun can surely also cause redshifts, the range of conditions under which this happens, which would have to be calculated, seems to me to be extremely narrow. The "battle" raged on for a few years. Vigier's views have not had a full hearing, to be sure. Perhaps his enthusiasm wasn't so great that he was willing to rewrite an article twenty times before convincing someone; more often than not, he would go off looking for a new effect. Nevertheless, a new version of the Big Bang has begun to emerge, *without* the initial singularity, even in the works of adherents of the "old" Big Bang (Reeves and Hawking, for example). This must be seen as the outcome, though not a completely logical one, of the offensive waged by the critics of the Big Bang (I am thinking of Hoyle and Burbidge, as well as Vigier and myself) as well as the discovery of abnormal redshifts (mainly by Arp) that do not necessarily support the new Big Bang, and Narlikar, who is seeking a quantum phase at the origin of the expansion, as well as the proponents (Linde and others) of an inflationary model.

It has been an uphill battle all the way. I am surely not exaggerating when I say that, by defending the point of view of Vigier and myself (not always in a way we would have approved of!), many young colleagues—and here I have in mind the APEIRON group—have, in a sense, kept the flame alive, and confirmed Jean-Pierre's ideas. Valuable contributions have also come from his many students and co-workers in Greece, Italy, Spain, Austria, Finland, Great Britain... and France.

What this all means is that the *cosmological constant* cannot be equal to zero; very likely it is not even uniform, just as the density of matter is apparently not uniform. If the cosmological constant has a nonzero value, then as Sakharov has pointed out, it represents the energy of the vacuum. Could it also give us the temperature at which matter, photons and gravitational waves are in equilibrium?

Most recently, Vigier has focused on this problem, showing that the interaction of a nonzero mass photon with a Dirac covariant ether indeed results in a redshift, but without any deflection that would cause a blurring in the images of distant sources. That is how things stand... for now, that is!

As we have seen, Vigier is a dedicated champion of daring new concepts that are not accepted by the scientific community. His philosophical positions are clear: causality, determinism, a vision of evolution in the Universe implying statistical stability that challenges the classical interpretation of the second principle of thermodynamics. But that's another story. I will close this all too brief summary of the works of Jean-Pierre Vigier here.

One conclusion is unavoidable. Vigier isn't really 70 years old: he's like a young man! His inspiration will carry him further along his path of discovery, and encourage young researchers, especially those who are not too concerned with pleasing the "establishment", to set out on the challenging, if not dangerous, road to new knowledge.

Jean-Pierre has indeed seen his share of danger! Dear friend, may you face more challenges, and possess the strength to arrive at conclusions that are both coherent and convincing, because convincing one's peers is the final phase of the scientist's mission. When you work, by choice, in the no man's land outside the bounds of the familiar, against "received" theories, the perils are ever-present.

I wish you smooth sailing, Jean-Pierre! And beware the jackals of conformity!