Cosmology, Fusion & Other Matters

George Gamow Memorial Volume

OLORADO ASSOCIATED
UNIVERSITY PRESS
Boulder, Colorado 80302

Cosmology, Fusion & Other Matters
GEORGE GAMOW MEMORIAL VOLUME

Cosmology, Fusion & Other Matters

Edited by

Frederick Reines

GEORGE GAMOW MEMORIAL VOLUME

16. Out of this World

Max Delbrück

Fleeting Apparition, Goettingen 1928

In the Café Kron & Lanz, in the heart of town, you could sit by the window on the second floor and watch life go by. Somebody pointed out to me a slightly sensational figure: a Russian student of theoretical physics, fresh from Leningrad. That was something new: few Russian scientists had been seen in Germany since the Revolution, certainly no students. This one had even written an interesting paper, on α-decay, or was in the process of doing it. And quite a figure he was too: very tall and thin, looking even taller for his erect carriage, blond, a huge skull, and a grating high-pitched voice, "Das Vögelchen im vierten Stock," Pauli said; talking a German (or any language) of his own, without the slightest hesitation, articulate, playful, irreverent, and thoroughly unconventional.

Prelude, Bristol 1930

My first postdoctoral year was spent in Bristol. The British Association (counterpart of the A.A.A.S.) met there in September. Dirac was billed with a major address, "The Proton." Landau, blithe spirit, came to Bristol to hear this speech. Would Dirac say something sensationally new? Something more than what was

contained in his paper on the theory of holes which had appeared a few months earlier? At that time, Dirac had considered the holes as representing protons. The positron had not yet been discovered. It turned out that the lecture did not bring anything new. Landau and I sat together on a back bench craning our necks and making snide asides. On the way home Landau (who was put up in the rooming house of Miss Stapleton where C. F. Powell and I stayed) stopped at a post office and casually sent a telegram: "Niels Bohr, Copenhagen. Quatsch." "Quatsch" is the German equivalent of "baloney," but more forceful. Landau said this was the code agreed on with Gamow to summarize Dirac's talk. He sent it to Bohr to complicate things a little. Indeed Bohr was quite puzzled for a few days, until Gamow happened to see the telegram and explained the code.

Stark Reality, Copenhagen 1931

Gamow and I roomed together, in the Pension Have, Triangle 2, two minutes from the Institute. At first we were in the same room, then each in his own. It did not make much difference. I might go to bed and be asleep; around midnight he would come in, turn on the light, settle down by my bed, unpack beer and hot dogs and discuss the evening's adventures: what she had said, and what he had said, or what practical joke to play tomorrow.

I had arrived in Copenhagen on a morning in February. That same evening Gamow persuaded everybody to go to a movie: ten postdoctoral fellows and Niels Bohr, the professor. Eleven people, eleven different nationalities. With Bohr, the only Dane in the crowd, Gamow's persuasion was only partially successful; Bohr yielded to psychological pressure to the extent of coming with us to the theatre, but by the time we got there his bad conscience got the better of him and he returned home in the same taxi.

I had come from Bristol to Copenhagen, the proud possessor of a black bowler hat, in emulation of Dirac: the counterpart of a beard today, and as provocative. Within a few days Gamow had poured liquid air into this hat. On dropping it, a piece the shape of Africa broke out of the crown. This was sent as a postcard to a friend in Goettingen.

A Challenge Taken Up

The year 1931 opened with a stunning stunt: the January 9 issue of the *Naturwissenschaften* contained a Kurze Originalmitteilung

entitled "Concerning the Quantum Theory of the Absolute Zero of Temperature." The note was signed by G. Beck, H. Bethe, W. Riezler, three German postdoctoral fellows at the Cavendish Laboratory. It read:

> Let us consider a hexagonal crystal lattice. The absolute zero of this lattice is characterized by the fact that all degrees of freedom of the system are frozen out, i.e. all inner movements of the lattice have ceased, with the exception, of course, of the motion of an electron in its Bohr orbit. According to Eddington every electron has $1/\alpha$ degrees of freedom where α is the fine structure constant of Sommerfeld. Besides electrons our crystal contains only protons and for these the number of degrees of freedom is obviously the same since, according to Dirac, a proton is considered to be a hole in a gas of electrons. Therefore to get to the absolute zero we have to remove from the substance per neutron (= 1 electron plus 1 proton; our crystal is to carry no net charge) $2/\alpha - 1$ degrees of freedom since one degree of freedom has to remain for the orbital motion. We thus obtain for the zero point temperature $T_0 = -(2/\alpha - 1)$ degrees. Putting $T_0 = -273°$, we obtain for $1/\alpha$ the value 137, in perfect agreement within the limits of accuracy with the value obtained by totally independent methods. It can be seen very easily that our result is independent of the particular crystal lattice chosen.

The way we read papers, then as now, with absolute trust in the good intentions of authors and publishers, one had to look twice or three times to switch from puzzlement through outrage to the realization of being confronted with the rarest thing in science: a joke! And what a joke! The editor of the *Naturwissenschaften*, the charming and highly intelligent Mr. Berliner, had fallen for it! Even the great Sommerfeld in Munich had asked Dr. Riezler in all earnestness, at the end of a seminar, to explain his recent note to the audience. Gamow could not sleep for a week. Somebody had outdone him!

Berliner was furious. He demanded an apology from the authors. On March 6 there appeared a "Correction" in the *Naturwissenschaften:*

> The Note by G. Beck, H. Bethe and W. Riezler, published in the January 9 issue of this journal, was not meant to be taken seriously. It was intended to characterize a certain class of papers in theoretical physics of recent years which are purely speculative and based on spurious numerical agreements. In a letter received by the editors from these gentlemen they express regret that the formulation they gave this idea was suited to produce misunderstandings.

Next day Gamow had his plan: wait for another outrageous paper, convince Berliner that he again had been victimized by a prankster and pressure him to publish another retraction. We did not have to wait long. On April 4 there appeared a Note by A. V. Das, "Origin of Cosmic Penetrating Radiation," rather similar in style, as a matter of fact, to the one by the Cambridge trio, and perhaps just as absurd. Now "the plan" went into effect: Gamow wrote to Berliner from Copenhagen, Rosenfeld sent his letter via his home base in Liège, and Pauli was to write from Zürich, all three to the same effect: The morals of the young generation are deplorable, outrage about the Beck-Bethe-Riezler scandal, satisfaction at seeing Berliner's "Correction," dismay at seeing him victimized again.

Gamow got a curt reply, suggesting that he was mistaken about the author's intent. A few days later, Rosenfeld got this reply, forwarded from Liège:

> Dear Mr. Rosenfeld: The paper by Das had already brought me a similar sharp protest from Gamow. I have now discussed the matter with Professor Kolhörster. The latter is of a slightly different opinion. Of course the paper presents an enormously far-fetched idea, extremely unlikely to be true, and quite unverifiable. However, I believe that one cannot compare a wild speculation, presented as no more than, let us say, numerology, with the thing of Beck, Bethe, and Riezler which you rightly describe as a schoolboy's prank.
>
> For me as Editor these short notes are at times a real curse, but I am afraid I cannot discontinue them.

At this point Bohr learned about the plot emanating from his institute. "These Russians (Landau had just left) are so refreshing!" He was torn between amusement and fear of offending his old friend, Berliner. What should he do about it? Send Gamow to

Berliner to explain? But what had Pauli done, from Zürich? Had he, too, written, as agreed over the last bottle of wine in Copenhagen? After a long wait, word came that he had weakened. In a more sober mood he had not been able to bring himself to do the old man in.

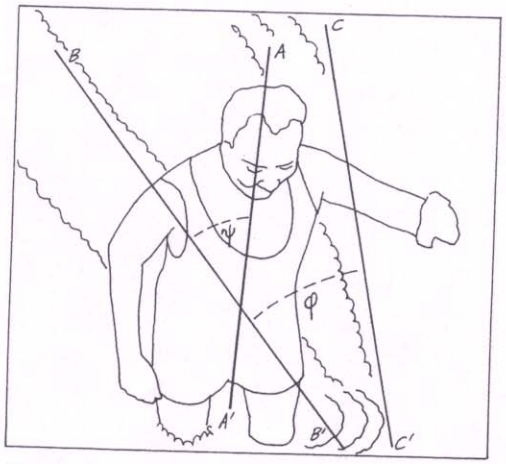
Applied Physics

In early summer there was a meeting in Zürich, followed for a few of us by a few days in Ascona (Lago Maggiore). We swam, lay on the beach and talked, and Gamow took a few snapshots. Back in Copenhagen one photograph intrigued him no end and gave rise to a whole week's distracting discussions and experiments and to a little paper by Gamow and Rosenfeld, entitled "On the Determination of the Velocity of an Object Moving in a Fluid on the Basis of a Single Photograph."

Figure 1 of this paper shows Pauli in bathing suit in the lake, gingerly stepping, his legs surrounded by surface ripples.

Here is the paper, translated from German and published

Figure 1.



for the first time after lying forty years in the archive of the Bohr Institute:

ON THE DETERMINATION OF THE VELOCITY OF AN OBJECT MOVING IN A FLUID ON THE BASIS OF A SINGLE PHOTOGRAPH

By G. Gamow and L. Rosenfeld,
Copenhagen

It is well known that the motion of a solid object through a fluid produces surface waves which propagate with the group velocity (cf., Lamb 1940)

$$w = 1/2\,\frac{\lambda g}{2\pi} \tag{1}$$

(λ = wavelength, g = 981 cm. $\times$ sec^{-2}).

Knowing the angle χ between the direction of motion of the object and the wave front, one obtains for the velocity of the object the simple relation

$$\frac{v}{w} = \operatorname{cosec} \chi. \tag{2}$$

In Figure 1 such wave groups can be discerned very clearly; but because of the unknown inclination of the photographic plate relative to the water surface one can not immediately read off the angle χ. It appears, however, that by measuring finer details of the picture this inclination α can be determined: it turns out that there

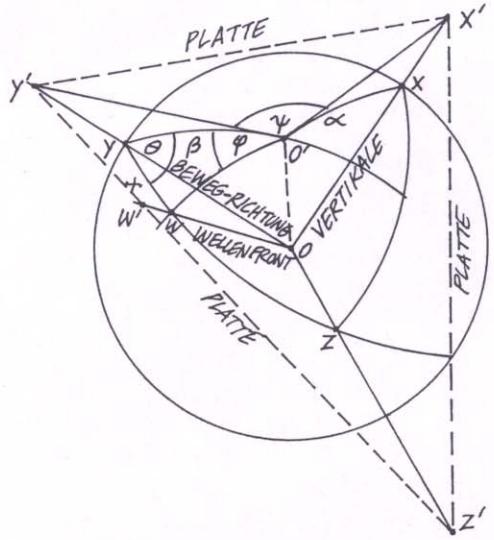


Figure 2.

are, spreading from the left leg of the object, circular waves which on the photograph appear as ellipses. From the axial ratios of these ellipses we obtain with sufficient accuracy $\cos \alpha = 5/11$. We know further the projection ϕ of the unknown angle χ onto the photographic plate, as well as the angle ψ between the projections BB', AA' of the direction of motion and the vertical. These data suffice to obtain χ with the help of a simple trigonometric argument which should be obvious without further explanation by inspection of Figure 2. We thus obtain

$$\operatorname{cotan} \chi = \frac{1}{\sin \beta} \{\cos \beta \cos \theta + \sin \theta \operatorname{cotan} \phi\}. \qquad (3)$$

Here the auxiliary quantities β and θ are given by

$$\begin{aligned} \cos \theta &= \sin \alpha \sin \psi \\ \sin \beta &= \cos \beta \operatorname{cosec} \theta. \end{aligned} \qquad (4)$$

From the photograph we obtain $\phi = 32°40'$, $\psi = 48°42'$; thus from equation 3, $\operatorname{cosec} \chi = 2.2$.

We now obtain the wavelength λ from the photograph in connection with the known absolute size of the object. Thus $\lambda = 7$ cm. Equation 1 now yields $w = 16.5$ cm $\times$ sec^{-1} and finally

equation 2 yields for the unknown velocity of the object $v = 36.3$ cm $\times$ sec^{-1}.

We thank Professor Pauli cordially for suggesting this paper and our dear friend and colleague, Dr. Delbrück, for many critical remarks.

Copenhagen, Institut för teoretisk Fysik
June 7, 1931

The thanks to me at the end of this note were caused by the fact that I had told the authors a dozen times to leave me alone with this nonsense.

Bohr loved this paper and so did Ehrenfest, who came to visit. The latter submitted it to *Physica*, a Dutch physics teacher's journal. Alas, they did not accept it. Here is Ehrenfest's letter, returning the manuscript to Gamow and Rosenfeld:

Leiden, Holland
July 8, 1931

My dear colleagues:

I have the honor to inform you that Professor Fokker has presented your paper to the Editorial Committee of "Physica" and that your method was considered beautiful and interesting and that they, therefore, would be very happy to publish your paper provided that it is demonstrated with a more suitable object. I presume, if I understand correctly, that this means that it should be an object from nonliving nature or perhaps a plant or an animal.

Because of the shortness of the reply received by me I am not in a position to judge whether the Committee was afraid that there might be involved in the example chosen by you an incalculable correction, due to the influence of the so-called "soul" of the moving object.

Possibly the Committee was also influenced by a linguistic difficulty which one senses immediately if one tries in a logically precise way to define in any modern language the position of point A' which is so crucial for the whole method.

I remain, my dear and respected contemporaries, as ever at your service,

Your
P. Ehrenfest

Enough! A brief spring and summer out of a lifetime! Enough for ordinary mortals. We might be carried along for a while but could not keep it up. These Russians didn't just *talk* jokes, they *lived* them! They were certainly out of this world.

Reference

LAMB H. 1940 *Hydrodynamics* (Cambridge: Cambridge University Press) p. 382.

17. Nuclear Reminiscences*

Leon Rosenfeld

I have been asked to tell you some of my memories from the prehistory of nuclear physics, and I gladly respond to this suggestion, even though it is always a bit melancholy to be reminded that one has reached the age of reminiscences. There is another circumstance which will tinge my speech with some melancholy. One character that looms large in my memories is George Gamow; I had hoped to describe some of our experiences of those days with a light touch, but his recent death has changed the character of what I will tell you about him: it will be an homage to the memory of one of the pioneers of nuclear physics.

In my experience nuclear physics starts with the sudden appearance, one morning in the library of the Göttingen Institute, of a fair-haired giant, with shortsighted, half-shut eyes behind his spectacles, who introduced himself, with a broad smile, by declaring: "I am Gamow." This announcement, at that time, could not provoke very much excitement. As it turned out that Professor Born would

* Transcription of a speech given at the State University of New York, Albany, on 5 October 1968.