

## SOME REFLECTIONS ON GEORGE GAMOW'S CREATIVE STYLE

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**ABSTRACT.** We discuss some aspects of the rich scientific legacy of George Gamow. Our analysis is based partly on Gamow's own scientific and popular books and articles, partly on reminiscences of his contemporaries. A special attention is given to G.Gamow's contribution to deciphering DNA genetic code and to the peculiarities of the "creative laboratory" of this unique figure in XXth century physics and cosmology.

**Key words:** history of astronomy, personalia: G.Gamow.

Distinguished guests, dear colleagues and friends.

Let me start with some remarks of a personal nature. It is a joy for me to be among the attendees of George Gamow's memorial conference. It is also a homecoming: almost forty years ago I graduated from the Mechnikov University in this charming city.

We have just heard a vivid and highly emotional talk presented by Professor of Colorado University, Igor Gamow who shared with us his impressions of an early childhood, reminiscences of his father accompanied by a touching amateur film commemorating George Gamow in a family circle. While I was watching so many young faces in this hall it seemed to me as if Georgij Antonovich's spirit was hovering somewhere inside these walls.

In my small contribution I will try to concentrate on some peculiarities of George Gamow's unique creative style without going into the technical details of his fundamental discoveries. This will be the subject of presentations prepared by cosmologists, specialists in relativity and theoretical physics. My modest analysis is based partly on Gamow's own books- "Thirty years that shook physics", "One, two, three... infinity", "Biography of Physics" and on two memorial volumes "Cosmology, Fusion and other Matters" and the most recent one - "The 1996 George Gamow Symposium" (held in Washington). It can be regarded as a continuation of my earlier article published three years ago in *Astronomical & Astrophysical Transactions* (see volume 10, p.167) and was based on my talk presented almost exactly five years ago at the first George Gamow international conference held in his home town. In that

earlier publication we emphasized that Gamow's rich scientific legacy is being constantly reassessed because many recent spectacular achievements in space research and observational cosmology have brought about numerous confirmations of his prophetic forecasts.

One of the most amazing features of his talent is Gamow's lucid, transparent way of treating the most intricate problems of theoretical physics, visuality of his physical models, which manifests itself in the best way in his popular books still bringing his author a public recognition from world-wide audience after his earthy life. Let me illustrate this thought with just two examples. In his critical essay reviving Gamow's crucial role in elaborating the drop model of atomic nucleus American historian of science R.H.Stewer offers a straightforward explanation: "Possibly the very shape of the nuclear potential well - which when viewed from above resembles a volcanic cone containing energetic alpha particles inside it - sparkled his thoughts (The 1996 Gamow symposium, p.36). Here is another, perhaps, even more striking example of what S.Ulam defines as Gamow's urge "to find even in most abstract theories, motivations or similes, i.e. analogies with precisely understood models" (Cosmology, Fusion and other Matters, G.Gamow's memorial volume 1972, p.60). In his popular book "Biography of Physics" Gamow introduces an uninitiated reader to a rather intricate notion of quantum mechanics - penetration by alpha particle through a high potential barrier surrounding uranium nucleus. He uses a "visible simile", analogy between de Broglie waves and the waves of light. As always, he makes himself illustration for his book and sketches the slab of glass reminding the reader a familiar in geometric optics phenomenon of the total internal reflection of light. Next making a mental experiment he draws another imaginary slab of glass supposedly only several wave-lengths away from the original one explaining through the Snail's law of refraction the difference between the geometric and wave optics thereby vividly illustrating how the photon can "jump" from one glass slab to the other without violating physical laws and thereby facilitating a comprehension of the mechanism leading to nuclear barrier penetration.

One cannot help feeling that this rare facet of

G. Gamow's numerous talents has something to do with his artistic perception of the world. Several following transparencies demonstrate Gamow's abilities of a gifted artist. Of all these cartoons the illustrations of a jocular parody on Goethe's Faust chosen as an epilogue to his last book "Thirty Years That Shook Physics", a unique collective gallery of the portraits of the greatest physicists of our time, occupy a special place. As we argued in our earlier paper, in a sense it is symbolic because the book was completed only for years before the death of Gamow.

So looking at Gamow's cartoons and illustrations, reading picturesque stories narrating this or that amusing episode almost invariably accompanying his fundamental scientific accomplishments I have always had an impression that there is more behind the superficial fabric of events. Indeed, the following fragment taken from Alex Rich's reminiscences of G. Gamow's substantial contribution to the solution of genetic code mystery is a tell-tale testimony of a rich "toolkit" in Gamow's creative laboratory. All of them served just one purpose to emanate the spirit of a "brain storm". A. Rich recalls an early history of discovery of genetic code and resurrects an atmosphere of a great excitement and curiosity following the publication by J. Watson and F. Crick the idea of double-stranded structure of DNA molecule. This event catalyzed Gamow's interest in 1958 to an extent that he wrote a letter to J. Watson and F. Crick and explained these gentlemen without many preliminaries his keen interest and strong motivation for solving the problem of DNA detailed structure. With his characteristic intuitive instinct for the new Gamow immediately recognized that from the moment of Watson's and Crick's discovery biology in a broad sense had entered the realm of the exact science. And realizing the advent of this crucial moment he embarked upon the task of constructing the physical model of DNA structure and in a full accord with his artistic perception of the world in large also of illustrative model. Because of a novelty and a great complexity of the task he even departed from his self-proclaimed principle (voiced in "Thirty Years that Shook Physics"): "I never liked to work in crowded places". Apparently Gamow himself was not very enthusiastic about his early individual efforts to analyze relative abundances of amino acids in proteins from tobacco mosaic virus (see his article "On Information Transfer from Nucleic Acids to Proteins", published in "Danish Biological Bulletin" and dedicated to the 70th anniversary of Professor Nils Bohr). So publishing a joint review paper with A. Rich and M. Ycas, Gamow with his coauthors creates a model in which they place DNA base-pairs, either adenine or thymine or guanine in a pair with cytosine along the DNA strand in a helical manner. In his own charismatic way of creating the atmosphere of improvised performance Gamow invents more or less during the same period the so-called RNA tie club.

It was composed of 20 members - one for each amino acid. Gamow even visited the haberdashery in Los Angeles and designed the ties depicting ring-like structures of purines and pyrimidines, the bases of RNA. So the first printing of RNA structure was manufactured on linens! The members of RNA club also had specially designed tie pins. Acting much as a producer or a stage director Gamow made a formal stationary for his club members. All of the members of the club were on the list of the stationary like actors in the stage production: Alex Rich was Lord Privy Seal, M. Ycas - archivist, F. Crick - the pessimist, Gamow himself - synthesizer. As in a good performance even minute details are important: even the pins with special engravings should not be distributed at random. One with inscription "Ala" belonged to Gamow himself (Why Ala? "I always wanted to be a God and now I have a chance to be one"...) etc, etc. The status of honorary members of RNA club was introduced with four members one for each base of RNA molecule on rotating principle so that each member of the club finally could enjoy the privilege of becoming the honorary member. Gamow had an insatiable appetite for jokes especially for practical jokes (one of them is a mockery article on measuring the velocity of a moving body in a liquid using a snapshot of W. Pauli's body as a "test particle" submerged in the waters of Geneva lake, the transparency of which I demonstrated you a couple of minutes ago). As Dr. A. Rich recalls, once Gamow organized a meeting of his close associates - A. Rich, F. Crick and others but without his personal attendance. Together with his friend Max Delbrück he composed a fabricated letter from another colleague - a biologist announcing a complete deciphering of RNA structure including all minor details with angles and distances and amino acids polymerized, all as established and well-known facts. It took four hours of heated discussions with placing the different pieces of evidence on RNA structure this way or the other before one of the participants, as A. Rich recalls it, had a hunch that all of them once again became victims of Gamow's whimsical way of creating a "team spirit".

Let me finish this paragraph with the concluding quotation from the same article of Dr. A. Rich: "What Gamow did was to bring a kind of enthusiasm to the problem, and an intensity and focus. Likewise he pulled a large number of people from physical sciences into this kind of biology, later called molecular biology. I think this represented a kind of a turning point, because it changed the evolution of molecular biology, and pushed it forward into a field in which physical scientists could work closely and well with biological scientists and make a significant contribution." An intriguing question, which invariably emerges, whenever a scientific legacy of an eminent nuclear physicist is scrutinized, is an issue of the so-called Oppenheimer's syndrome. To what extent G. Gamow was prone to this

syndrome, how much reflections on devastative nature of the forces released from the "bottle" by him and his colleagues engaged in the chain reaction project pre-occupied his inquisitive mind? It is well-known that during the World War II Gamow worked at the American Navy high explosives laboratory with A. Einstein himself and with J. von Neumann. After the war Gamow was involved in the Bikini bomb test to study the effect of nuclear blast shock waves on the surface structure of ships and on hydrogen bomb project at Los Alamos jointly with E. Teller (for more details see the reminiscences of F. Saafeld in "The 1996 Gamow Symposium", p.26).

It seems to us that Gamow's famous cartoons to some extent betray his uneasy thoughts on this delicate issue. It's well known that during his work in the famous T-division Gamow sketched several mockery shields (reminding one the medieval courts of arms) dedicated to the project. One of them depicts the leader of T-division Mr. Carson Mark. The shield is encircled on all sides by motto "For he is a good, jolly fellow". Close to a portrait of a hero Gamow places a sinister atomic mushroom. Another corner of the same shield contains a number of figurines, presumably, the children of "jolly, good fellow" crawling out of something which look either as a belly of a whale or as a horn of plenty. Unwittingly, the whole picture emanates some apocalyptic-sarcastic or even sardonic expressiveness. Here is another (this time both amusing and ironical) example of G. Gamow's evasive style of treating the same ticklish subject. In his book "One, two, three... infinity" he muses: "In respect to nuclear energy we live (or rather lived until quite recently) in a world similar to that of Eskimo, dwelling in a subfreezing temperature for whom the only solid is ice and the only liquid alcohol. Such an Eskimo would never have heard about fire, since one cannot get fire by rubbing two pieces of ice against each other, and would consider alcohol as nothing but a pleasant drink, since he would have no way of raising its temperature above the burning point. And the great perplexity of humanity caused by the recently discovered process of liberating on large scale the energy hidden in the interior of the atom can be compared to the astonishment of our imaginary Eskimo when shown ordinary alcohol burner for the first time" (One, two, three... infinity, p.168). Curiously enough, in the same book Gamow confides the principle of statistic disorder and even the burning question of the difference between living and non-living forms of matter again addressing the meaningful figure of alcohol. "We should have a much closer analogue of a biological process if, for example, the presence of a single alcohol molecule ( $C_2H_5OH$ ) in a water solution of carbon dioxide gas should start a self-supporting synthesizing process that would unite one by one the  $H_2O$  molecules in the dissolved gas forming new molecules of alcohol. Indeed, if one drop of whiskey put into glass

of ordinary soda water should begin to turn this soda into pure whiskey, we should be forced to consider alcohol as living matter" (One, two, three... infinity, p.236). And following this passage Gamow proceeds to a description of recent progress in studying the structure of the simplest living forms - viruses. So why spirituous after all? Because it is as **contagious** as the virus or because G. Gamow himself brooding over the eternal questions of good and evil of his epoch, over the fate of his homeland, from time to time looked into the glass in a desperate search for an answer to questions tormenting him (see an article of D. I. Ivanenko in the supplement to Gamow's biography "My World Line" describing the difficult episodes in Gamow's life)...?

Close friends called him affectionately Geo. If one recalls the original meaning of the word for all of us, the inhabitants of this planet, it brings us once again to Goethe's immortal figure of doctor Faust. The concluding fragment (in Russian translation from Boris Pasternak) is equally applicable to an unique personality of Georgij Antonovich Gamow:

"On rvetsja v boj, i ljubit bratj pregrady, i vidit celj, manjashchuju vdali, i trebujet u neba zvezd v nagradu, i luchshih naslzhdenij u zemli, i vek jemu s dushoj ne budet sladu, k chemu by poiski ne priveli".

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## References

- Gamow G.: 1955, "On Information Transfer from Nucleic Acids to Proteins, *Biologiske Meddelelser*, bind **22**, nr.8, 1.
- Gamow G.: 1961, *Biography of Physics*, Harper and Brothers Publishers, New York, 280.
- Gamow G.: 1961, *In: One, two, three...infinity*, The Viking Press, New York.
- Gamow G.: 1966, *Thirty Years That Shook Physics, the Story of Quantum Physics*, Heinemann, London.
- Ivanenko D.D.: 1994, "Gamow's Epoch Seen with the Eyes of His Contemporaries", *In: G. Gamow, My World Line*, ed. Ju. Lisnevskij, VO Nauka, Moscow, 278.
- Pustyl'nik I.: 1997, *Astron. & Astrophys. Trans.*, **10**, 167.
- Rich A.: 1997, "Gamow and Genetic Code", *In: The 1996 Gamow Symposium*, ed. Harper E., Parke W.C., Anderson G.D., 115.
- Ulam S.: 1972, *In: Cosmology, Fusion and Other Matters, G. Gamow Memorial Volume*, ed. Frederick Reines, London, 272.