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HEAVY ION PHYSICS
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Valentine Telegdi Eighty

Valentine Telegdi (Telegdi Bálint) was born in January 1922. Now his native country greets his cosmopolitan son, who is the most original experimentalist among the theory-oriented scientists of Hungarian roots.

Valentine's father worked for shipping companies in coastal countries. His son was born in Budapest and left the country at the age of one month. – *As you see, in one month I learned speaking Hungarian rather well* – he used to say when giving lectures in Budapest in perfect Hungarian. After living in different countries, the family brought Bálint back to Budapest (1928), in order to offer him a chance to attend school and to learn reading and writing in Hungarian.

In 1930 the family moved to Vienna, where Valentine attended Realgymnasium till the Nazi invasion. The first encounter with science happened there, when Val got a chemical set as birthday present. An extraordinary physics teacher made a great impression upon him. Noticing the young man's interest in atoms, Dr. Pechinger recommended to him Sommerfeld's "*Atomic Structure and Spectral Lines*". But upon reading it, Val became worried because "the book was full of strange snake-like symbols, like $\int$ ". Thus, at the recommendation of his teacher, Val educated himself in differential and integral calculus, and at the age of 16 he learned to derive the hydrogen spectrum from Sommerfeld's quantum rule $\int dp\, dq = n\mathrm{h}$.

His father worked in shipping business in the Mediterranean. After the Nazi occupation of Austria (1938) Valentine managed crossing the Italian border. But even the Italian intermezzo could not last for long. When German troops entered Italy, Val and his mother entered Switzerland – illegally, assisted by professional smugglers (1943).

Valentine studied chemical engineering at the University of Lausanne (1944–1946), concluding with a Master's Thesis on "*Counting Loss Corrections in Radioactivity*" (i.e. taking the dead time of Geiger counters into account). The interest of the young man focused already onto quantum phenomena, and crossing disciplinary boundaries he began graduate studies in physics at the Eidgenössische Technische Hochschule (ETH) in Zurich. At the ETH the leading personality was Wolfgang Pauli, renowned more for his very sharp critical comments than for lucid lectures. The referees of Telegdi's Ph.D. thesis were Scherrer and Pauli – but Valentine survived it. After the exam, Pauli even invited Telegdi for a glass of wine.

In Scherrer's institute Telegdi was put to work with photo-emulsions, recently introduced by the Bristol group as track detectors. He studied the photo-disintegration of carbon nuclei: $\gamma\ +\ ^{12}\mathrm{C} \rightarrow 3\ ^{4}\mathrm{He}$. Telegdi imagined this nuclear reaction to be analogous to the disintegration of ozone molecule: *light* + $\mathrm{O_3} \rightarrow \mathrm{O_2} + \mathrm{O}$.

By studying the momentum distribution of the emerging α-particles, Telegdi showed that the nuclear disintegration indeed goes via the Be nucleus, namely γ + ^{12}C $\rightarrow$ ^{8}Be* + ^{4}He, then ^{8}Be* $\rightarrow$ 2 ^{4}He. Telegdi calculated the energy of the excited ^{8}Be* nucleus from the observed energy distribution of the α-particles. In the Ph.D. thesis he developed the α-particle model of nuclear structures.

In the fall of 1948 Scherrer sent Telegdi to Bristol to learn more about the photo-emulsion technique. In Bristol, Telegdi learned good technique but felt little of the spirit of the New Physics. Thus he did not accept a job offered him in Bristol. He recalled in his informal autobiography (1989): – *Most experimental chairs were filled by former students of Rutherford. This had, to my mind, a devastating consequence. Lord Rutherford always prided himself to be a "simple-minded fellow", ignoring quantum mechanics. His disciples elevated theoretical ignorance to the level of virtue. Theoretical physics, in the continental sense, was brought to Britain only by Hitler's escapees: Bethe, Fröhlich, Heitler, Peierls etc. Quite aside from the anti-theoretical Bristol approach, I had already adapted Goucho Marx' principle: "I don't care to join any club that is willing to accept me." I started to look for the most exclusive university possible and I found it: Chicago.* – Edward Teller's early interest in the composite α-particle model of nuclei was a factor in this choice.

Weisskopf wrote a letter of recommendation to Enrico Fermi at Chicago, in support of Valentine Telegdi's application. But 1950 was the peak of the McCarthy era. After some wrestling Telegdi received an exchange visitor's visa, but the visa for his wife was refused. They both received U.S. visa only in 1951. A few days after the arrival at Chicago University, Valentine visited the Institute of Biophysics, to meet Leo Szilard. Telegdi approached Szilard not only as a fellow Hungarian, but because his father knew Leo's sister. (Her husband had been interned in Normandy with him during World War I.) They talked in Hungarian. Mrs. Telegdi became Szilard's secretary. She claims that – *Szilard was the most brilliant person I ever met.*

Telegdi interacted mostly with the "young Turks" like Garwin, Gell-Mann, and Goldberger. He used the betatron but – "*because of his Hungarian origin and of Wigner's influence*" – developed interest in the group theory of the nuclear isospin as well. He was further interested in the α-particle structure of the ^{12}C nucleus and studied the γ + ^{13}C $\rightarrow$ ^{12}C + n reaction. The central machine in Chicago, however, was the cyclotron, producing π-meson beams under the leadership of Fermi, who was the central figure in Chicago.

Then the Great Year of 1956 has arrived in the life of Valentine Telegdi. In order to explain peculiar transitions in the decay of heavy mesons, T.D. Lee and C.N. Yang got the idea that the weak decays violate parity conservation, i.e. the left–right symmetry of Nature. The first experimental confirmation showed that the spinning radioactive cobalt nucleus emits the electron preferably in the "South" direction – if you use the spin of the nucleus for directional orientation. (At the β-decay of neutron nuclear rotation and electron velocity make a left-handed screw.) The reflection symmetry with respect to the "Equator" has been violated! Only simultaneous space and charge reflection is a valid symmetry of weak interactions.

At learning about the cobalt experiment, Leo Szilard commented to Telegdi: – *This means that if a cobalt atom looks at the mirror, it does not see itself, but an anti-atom!* – But how to prove this, how to make experiment with an "anti-atom"? In 1957, respected physicists considered the possible left–right asymmetry of Nature to be a mad idea. Telegdi was advised by his senior colleagues not to waste effort on this problem. But instead of nuclei, Telegdi used an unstable elementary particle and proved that the positive *muon* decays "northwards". (In case of positive muon-decay the muon-rotation and positron-velocity make a right-handed screw, in case of negative muon-decay the muon-rotation and electron-velocity make a left-handed screw.) The experiment was made difficult by the fact that the muon lives only 2 millionth of a second ...

Performing such an "impossible" experiment brought Telegdi fame; the short-lived muon became his favorite object of research. Telegdi became an experimental wizard: he also measured that neutrinos from muon capture are polarized in the same way as those originating from nuclear β-decay. Dick Garwin supplied the idea that by magnetic field one could turn its magnetic moment at will. The direction of the magnetic moment is indicated by the outgoing electron. Thus Garwin and Telegdi were able to measure the magnetic moment of this elusive particle up to several decimals. Because the muon is not affected by complicated nuclear forces, it can be used to study weak and electromagnetic interactions under much cleaner conditions than in the case of nuclei. The measured magnetic moment anomaly of the muon agrees perfectly with the calculated theoretical value, this is one of the most beautiful proofs of the standard theory of electroweak interactions.

In 1972 Valentine Telegdi was awarded the "*Enrico Fermi Distinguished Service Professor*" title at Chicago University. In 1976 he moved back to Zürich, as professor at the Eidgenössische Technische Hochschule. Nowadays he spends most the year in Switzerland (in Geneva, at CERN), the winters in California (in Pasadena, at CalTech). He revisits Hungary frequently, last time he did in the fall of 2000. Telegdi has been elected a member by the academies of Hungary, Italy, United States, Russia. In the U.S., Switzerland, Italy, Hungary, in each of his home countries he lectures in the local language. For his brilliant experimental clarification of the nature of weak interactions, Valentine Telegdi received the Wolf Prize (1991).

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