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SIR C.V. RAMAN AND HIS CONTACTS WITH HUNGARIAN SCIENTISTS

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Sir C.V. Raman, India's only Nobel Laureate in the field of physics was either a Honorary or a Foreign Fellow of a number of Science Academies in the world. In this short communication his contacts with Hungarian scientists are explored.

Key words: Chandrasekhara Venkata Raman, György [George] de Hevesy, Hungarian Academy of Sciences, Indian Academy of Sciences, Károly [Karl] Tangl, Max Born, Raman effect, Rudolf Ortvay, Scientific Community.

INTRODUCTION

The Hungarian Academy of Sciences (henceforth HAS) was founded in 1825 due to the efforts of Count István [Stephen] Széchenyi (1791-1860), a leading figure of the reform era in Hungary, who donated one year's total income of his estates for this purpose[1]. Its objective was fostering of vernacular language and the cultivation of sciences and arts. Most probably, C.V. Raman was one of the rare persons from India, who became its Fellow. Though there are many biographies of Raman, which deal with different aspects of his life and scientific work[2], yet none has explored Raman's contacts with the Hungarian scientific community. The present article sheds some light upon this issue.

To start with short biographies of the two Hungarian physicists are presented who nominated Raman for the Honorary Fellowship of the Hungarian Academy of Sciences.

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RAMAN'S NOMINATORS - KÁROLY [KARL] TANGL AND RUDOLF ORTVAY

The biographical data given in the following paragraphs is largely taken from the booklet, *Physics in Budapest – A Survey*[3].

Károly Tangl (1869-1940): Tangl was assistant to Baron Loránd [Roland] Eötvös (1848-1919) – who was known as the 'Grand Old Man' of Hungarian Physics. Tangl later became a Professor of Experimental Physics at the University of Budapest. Due to his efforts cosmic radiation and crystal physics in Budapest were initiated. However, his still greater contribution to Hungarian physics was to select and promote talented students. For instance, in the end of the first decade of the twentieth century he took Rudolf Ortvay (1885-1945) as his assistant. Later Tangl sent him to the University of Göttingen (Germany), which was a center of learning in Europe in those days. Again it was due to Tangl that Ortvay had the chance to work under Arnold Sommerfeld (1868-1951) – one of the founders of modern atomic physics and known as a great authority. In the Hungarian science community (which was dominated by theoretical physicists), Tangl's pupils Zoltán Gyulai and Sándor Szalay established experimental researches in the field of crystal and nuclear physics at the University of Debrecen[4].

Rudolf Ortvay (1885-1945): Unfortunately, due to the political situation the Hungarian science suffered much during the first half of the twentieth century. Some of its scientists like Tódor [Theodore] von Kármán (1881-1963), György [George] de Hevesy (1885-1966) and Leo Szilárd (1898-1964) were forced to emigrate for fear of right-extremists, where as Jenõ [Eugene] P. Wigner (1902-1995), Ede [Edward] Teller (1908-...), János [John] von Neumann (1903-1957) went abroad due to the spreading anti-semitism in their home land[5]. They returned to their native land for short periods under favourable conditions. However, the case of Rudolf Ortvay is different.

Ortvay (Fig. 1) is supposed to be the man who 'kept physics alive in Hungary by his famous colloquia', which he initiated in 1929. He is considered as 'Pioneer of Modern Physics'. Ortvay who early was interested in medical and biology later spend some time under scientists Peter Debye (1884-1966) and Arnold Sommerfeld in Zürich and München respectively. After finishing his education he taught at Kolozsvár (today Cluj-Napoca,

Rumania), Budapest and Szeged Universities. His fields of interest were the theory of relativity, corpuscular theory of matter, and quantum mechanics[7]. Already in 1930s, when quantum mechanics was in its infancy Ortvay organised teacher training on quantum mechanics[8].

Fig. 1. The Hungarian physicist Rudolf Ortvay who visited various universities in India in the end of 1936 and the beginning of 1937 (Courtesy of HAS).

Ortvay was one of the main linking persons between Hungarian and foreign physicists. He nominated renowned scientists like Arnold Sommerfeld, Arthur Eddington (1882-1944), Niels Bohr (1885-1962), P. Debye, Max Planck (1858-1947) and C.V. Raman for the Fellowship of the HAS.

Raman's Hungarian Contacts

Ortvay who visited India (see details below) delivered two lectures at the Indian Institute of Sciences, Bangalore. The lectures published in the journal, *Current Science*, Bangalore are valuable documents to give some background of Hungarian-Indian connections. In one of the lectures entitled *Physics in Hungary – Past and Present – I*, the author informed that the Hungarian Sándor [Alexander] Kõrösi-Csoma, whose tomb was in Darjeeling, was the first person to compile á vocabulary of the Tibetan

language[9]. In the same communication after praising Baron Eötvös' work in the field of gravity and capillarity he stated that these methods were used in the field of oil/petroleum production. Three expeditions related to this topic were made between 1923 and 1926 in different parts of India under the leadership of Pekár Dezsõ, who directed these researches as Head of the Eötvös Geophysical Institute[10].

In 1927, nearly 10 years before Ortvay's Visit, Von Kármán, known for his work on lattice- and aerodynamics visited Calcutta. However, his interest was to meet the great Indian politician Mohan Das Gandhi. In his memoir *The Wind and Beyond*, Von Kármán wrote about a scientist from Delhi who made possible this contact and arranged a talk with Mahatma Gandhi. As a technician Von Kármán found Gandhi's ideas antiscientific and classical primitive[11]. Whether he met Raman or any other physicist in Calcutta is uncertain. After many years, that is, in 1961 he (Von Kármán) was elected Foreign Fellow of the Indian Academy of Sciences[12]. Other Hungarian scientists to become Fellows of the IAS were Pál [Paul] Erdõs[13] (1913-1996) – a genius mathematician, and G. Hevesy (elected in 1950[14]). The latter who is known for the discovery of the element Hafnium and the reception of the Nobel Prize in 1943 had closer contacts with Raman.

Hevesy, who due to political reasons, had voluntarily resigned his position on October 16, 1919 and on April 12, 1920 his lecturing right was revoked[15], later moved to Denmark to work with the eminent Danish physicist N. Bohr in his newly founded Institute in Copenhagen. There he stayed between 1920 and 1926[16]. Raman came in contact with Hevesy during one of his visits to Denmark. For example on February 25, 1925 Hevesy wrote to the Director of Radium Institute in Vienna, Stefan Meyer[17] (1872-1949) about Raman's visit.

It is well known that in Germany after Adolf Hitler came in power a law was passed that allowed the state to send a person in pre-mature retirement or devoid of his position under different pretexts. Scientists of Jewish origin or belonging to the political opposition were affected by it. Many left the country. Ernest Rutherford (1871-1937) – the famous British physicist known for his atomic model - on September 12, 1933 in a letter expressed his grievances for Hevesy if he had to leave his laboratory at the

Institute for Physical Chemistry at the University of Freiburg, Germany. In July 1934 Hevesy himself asked for his dismissal and the request was met on August 25, 1934[18]. Before this incident a special Readership in Chemistry created by Raman with the consent of the Council was offered to Hevesy[19]. According to the Minutes of the Council of the IIS, dated July 16-17, 1934, page 3:

> "The Director laid before the Council the unanimous recommendation of the Senate that Professor George Hevesy and Dr. Max Born be appointed as Reader in Chemistry ... for a period of six months during the year. This recommendation had been circulated to the Council together with a proposal that the honorarium for the period of 6 months ... be fixed at Rs. [Rupees] 15,000 inclusive of all expenses".

And further it was stated that 'A reply had been received from Professor Hevesy expressed his willingness to spend a period of six months at Bangalore from 1st October, 1934, to 31st March, 1935'. Under Resolution III this appointment was approved by the Council.

In August 1934 Hevesy wrote a letter to Rutherford and informed him about his resignation in Germany and his wish to move to Copenhagen in the middle of September. In the same communication he stated,

> "Raman invited me to spend the winter in Bangalore and take over temporarily the Chemical Institute. To spend a winter in India where I have not yet been is very tempting especially as the conditions offered are very liberal, however it is very doubtful if it will be possible to me to postpone the beginning of my activities in Copenhagen".

Just a month ago i.e. in July 1934, Hevesy wrote a letter to the physicist James Franck (1882-1964) who had been immigrated to the United States; and informed about Raman's offer and asked for advice. He mentioned that the financial conditions were very good (total 1100 British Pounds). But from scientific and intellectual points of view he was sceptical and was of the opinion that he had hardly a chance to broaden up his knowledge in India. Also he was worried that he had to leave his children in Freiburg. Apart from that in the middle of September (1935) he had to be in Copenhagen[20]. On August 18, 1934 in the next letter Hevesy thanked Franck for the prompt reply. In the end he was happy to give up his Indian plan. It seems that he did not inform Raman immediately as the Minutes of the

Council from November 19-20th, 1934, page 12 suggest. Here it was reported that Hevesy accepted the invitation from October 1, 1935 onward for a period of six months under the early stated conditions. At which stage Hevesy gave his final decision is unknown[21].

Before we proceed further, in the above context, it will be worthwhile to see the case of German theoretical physicist Max Born, who accepted Raman's offer and came to India[22]. Different authors have written about this stay[23]. I have explored the details of Born-Raman issue in a separate article *'Max Born's role in the lattice dynamic controversy'*[24]. There I have shown that from Born's private correspondences it is clear that his contract of three years in Cambridge was going to end. At the right time he got Raman's offer. Born's correspondence gives no clue about his expectations from this stay. According to his autobiography, his stay in India was scientifically uninteresting[25]. Other authors also interpret Born's stay in India as not particularly productive scientifically[26]. According to my own opinion, they ignore Born's five publications in the *Proceedings of the Indian Academy of Sciences*, and his activities for the cause of displaced Jews within India[27]. Born initially came for six months. After Raman gave him a hope for permanent chair, Born wished to stay longer as the salary was good, Born's wife also felt happy, and moreover, Born was not feeling well with his refugee status in England and wanted to settle down definitely. That is what Max Born wrote to Paul Dirac on October 28, 1935.

Ortvay in India

So far as Ortvay is concerned, it was Von Neumann who tried to help as is evident from Max Born's letter to the British physicist Paul Adrien Maurice Dirac (1902-1984). It reads: 'Ortvay is not an outstanding personality. May be that Raman has never heard of him. But I leave it to you to decide whether you will respond to Von Neumann's wish'[28]. However, Born suggested Dirac to contact Raman who might arrange some lectures[29]. But for a long time there was no reply[30], as Raman was in a critical position due to disputes in the IIS. In order to avoid further delay Born wrote to Raman's assistant P. Krishnamurty and asked to contact Raman's pupils in Calcutta or Waltair (Andhra Pradesh)[31]. Most probably due to the Born-Dirac plea, Raman decided to help Ortvay.

On October 17, 1936, Ortvay informed Dirac that he had an invitation to deliver a lecture in Benares [Hindu University]. He was also expecting to get similar invitations from other universities and colleges in India. His plan was to sail with a German steamer 'Potsdam' on December 22nd from Genoa and arrive in Colombo (Sri Lanka) the 2nd of January (1937). He wished to stay in India for two months and visit Bangalore, Benares, Calcutta and Rangoon.

On December 22, 1936 Raman wrote to Ortvay that 'I shall be extremely delighted to welcome you to this Institute. ... We shall be extremely pleased if you could give us one or two lectures on the subjects of your choice'[32]. For this work Ortvay was offered 350 Rupees[33]. Dirac was informed about the invitations and friendly letters from Raman and the founder of Bose-Einstein statistics - [Satyandra Nath] Bose[34]. Ortvay stayed in Ceylon and India nearly three months and delivered lectures in Bangalore, Benares, Calcutta and Waltair. 'Unfortunately I had spent only two weeks in Bangalore, which had the biggest scientific institute', wrote Ortvay[35].

There is no doubt that Ortvay was impressed by the hospitality of Indian physicists. After his return from India, he along with his teacher Tangl nominated Raman for the Honorary Foreign Membership of the HAS[36], as is obvious from Raman's letter that he wrote on June 24, 1937. It reads:

> "I am sorry for the delay in replying to your kind letter of the 24th March (1937) from Kandy (The Hotel Suisse – Kandy – Limited, Manager's Office, Ceylon). Since receiving it, I have also read your letter of 14th May and Archduke Joseph's letter informing me of my election to the honorary foreign membership of the Hungarian Academy of Sciences. I appreciate this honour very much indeed, and I am grateful to you for having proposed me for it"[37].

Raman who was always conscious to make the work of Indian scientists known abroad lost no opportunity and in the same letter wrote: 'I am ... arranging that the Hungarian Academy will get the Proceedings of the Indian Academy of Sciences regularly'[38].

It seems in the following years there was no deep contact as the nominators expired in the 1940s. Apart from that the political factors also played an important role. Hungary adopted the political and economic

system shaped on the pattern of the Soviet Union. The HAS was reorganised, and got the status of a supreme scientific body. However, the negative effects were that the humanity and arts group scientists as well as persons 'unfit for a political system' were no more members of the Academy. In 1989 all those members which were unjustly excluded in 1949 from the Academy were rehabilitated[39].

RAMAN'S VISIT TO HUNGARY

Under these political changes, the membership of the Foreign Fellows was also affected. The Hungarian scientific community found Raman as a worthy Fellow and in 1958 he was re-elected. István Rusznyák - President of the Hungarian Academy of Sciences (see Fig. 2) confirmed his early election of November 21, 1937 and on June 17, 1958 wrote to Raman as follows: 'I have the pleasure to invite you and your wife to participate at the meeting taking place in honour of your visit to Hungary'. Raman gladly accepted this invitation, to visit this country second time[40].

Fig. 2. István Ruszayák – President of the Hungarian Academy of Sciences, presenting the Diploma of Honorary Membership to the Nobel Laureate C.V. Raman (Courtesy Hungarian Academy of Sciences).

In Hungary, Raman and his wife (see Fig. 3-5) were entertained by the Hungarian scientific community. Under the auspices of the Hungarian

Physical Society, Raman delivered three lectures on *"The physics of crystals"*[41]. Raman not only visited Budapest, the capital of Hungary but also the University of Szeged. Raman gave an informal talk on *"The discovery of the Raman-effect"* (details below) at the Physical Institute of the Szeged University. The participants of the talk were the Hungarian scientists Ágoston Budó, István Kecskeméty, László Szalay, József Dombi, R. Horvai, József Gyulai, Ferenc Pintér, László Gombai (see Fig. 4-5).

Raman's talk at the University of Szeged

As in his unpublished lecture (its copy was supplied to the present author by Professor Lászlo Kovács[42]) there are some less known aspects, it is worthwhile to reproduce its details. Raman told that he enjoyed to see the blue colour of the sea. He asked himself why it was blue and stated,

Fig. 3. During the visit, Raman was accompanied by his life long partner Lady Raman. The portrait shows Mrs. Raman and Mrs. Budó, wife of Ágoston Budó – a member of the HAS (Courtesy HAS).

"During sunshine, I investigated the scattering of light at the surface of the sea. In the meantime I held lectures in Bombay on X-ray spectra. I discussed the phenomenon on the basis of the wave theory of light. The audience of the lectures were very pleased with the lectures and they (promised me to) publish them and offered 500 Rupees, if I would write down the text. I wanted to get 500 Rs., and I wanted to write the lectures for publication, but I was busy, I had no time. In the meantime I read a book on X-rays, discussed on the basis of the particle model of light. I saw that I have to rethink the text of my lectures. I have a keen interest to know which discussion is true. I worked a lot, calculated all things on the basis of the wave theory. All were O. K, except the Compton-effect[43]. It could not explain the larger wavelengths of the scattered X-rays " (Tr. from Hungarian).

Fig. 4. Raman's visit at the Institute for Experimental Physics – Technical University of Budapest. From left to right Sándor Szalay (1909-1987), founder of the Experimental Nuclear Physics School in Hungray, A. Budo, C.V. Raman, Zoltán Gyulai Jr., Mechanic A. Jedlisha and Dr. J. Horváth (courtesy HAS).

Raman, who in between derived *'A classical derivation of the Compton effect'*[44] informed in the talk that 'I thought there must exist an analogy in visible light as well. I made scattering experiments'.

He went on,

"The sunlight was passed through a dark blue filter to the water and the scattered light was observed with the help of a mica grating. I used simply a paper tube. It was closed with a slit on one end, and the grating on the other end. In this very simple spectroscope, I have seen in the scattered light in addition to the blue region a pale (faint) green stripe; this light was very weak.

I used a green filter and I observed in the scattered light a yellow stripe. It seemed I found the analogy of the Compton effect because of the appearance of the larger wavelengths. I have also to know if the larger wavelengths of the light were coming really from the scattered light. They could come as a luminescence in the water as well. I saw two ways to find the real answer. First I investigated the polarisation of the scattered light. I found that the degree of the polarisation was greater. We know from the investigations of Vavilov, that the polarisation of the emitted luminescence is greater in the viscous solution, in the water practically zero. Second I visually investigated the scattered light of a mercury lamp [presumably light scattered by probe] using a simple spectrometer. I found in the spectra in addition to the strong mercury lines (which were thick in my spectroscope) new lines (not a diffuse strip) in the region of the larger wavelengths. If the primary light was more monochromatic the strip in the larger wavelengths region was narrower. This situation does not exist in luminescence. I was sure that I had discovered the optical analogy of the Compton effect. Later this effect was named Raman-effect. Naturally I investigated the phenomena with a better spectroscope as well. I began these investigation in 1924 and finished in 1928. I was nominated for the Nobel prize in 1929[45], and the prize was going to me next year" (Tr. from Hungarian).

So far as the first part of Raman's lecture is concerned there is nothing to comment. However, the section related to the experimental work needs careful reading, as it differs from the narration given in the two publications from the year 1928. For instance, in their first paper "*A new type of secondary radiation*", Raman and his co-worker K.S. Krishnan used sun as source of light and, they write,

"A blue-violet filter, when coupled with a yellow-green filter and placed in the incident light, completely extinguished the track of the light through the liquid or the vapour. The reappearance of the track when the yellow filter is transferred to a place between it and the observer's eye is proof of the existence of a modified scattered radiation"[46].

In the above referred paper they stated that the intensity and the polarisation being different than in the case of fluorescence (which is an effect also with change of wave length). Thus they were sure that a new effect has been discovered.

In the second publication related to the discovery, Raman stated,

"A greater surprise was provided by the spectroscopic observations. Using sunlight with a blue filter as the illuminant, the modified scattered radiation

was readily detected by the appearance in the spectrum of the scattered light of radiation absent from the incident light. With a suitably chosen filter in the incident light, the classical and modified scatterings appeared as separate regions in the spectrum separated by a dark region. This encouraged us to use a mercury arc the source of light..."[47].

The comparison of published paper and unpublished lecture shows that: Firstly in the lecture Raman did not mention the complementary filter method, which was the real step towards discovery. Secondly, in the publications there is no mention of mica grating and a provisional spectroscope (made out of paper tube, slit and grating). Also, Raman's other publications show that he started intensively his work on scattering in 1921-1922 and not in 1924. The difference between the two statements seems to be due to the fact that Raman recalled an event after about 30 years. It is likely that he did not remember all in detail.

Fig. 5. Raman at the University of Szeged in the Department of Theoretical Physics. From left to right: Dozent Dr. Horváth Jánoshoz, C.V. Raman, Lady Raman and Ágoston Budó (Courtesy University of Szeged, Hungary).

Last Phase

After Raman's personal visit, the contact between the two academies became closer. In the beginning of the 1960s, György [George] Szigeti – an ordinary member of the HAS was elected an honorary fellow of the Indian Academy of Sciences to which Rusznyák responded as follows: 'I was pleased to learn that [Szeigeti has been elected as member of the IAS].. ... I

consider this recognition is a further step in making the scientific relations between our scientists and Academies closer'[48]. Obviously, the contact between Raman and Hungarian scientists were more than simple honours.

The last available document on Raman-Hungarian connection is his letter to Dr. Jánoshoz [John] Horváth, in which Raman thanked for a copy of a paper on *"The Internal Structure of Physical Fields"*[49].

Conclusions

George de Hevesy who was invited by Raman for the Readership in Chemistry at the Indian Institute of Sciences, Bangalore, did not come to India as he preferred to stay in Copenhagen. He was of the opinion that he could not broaden his knowledge in India.

Raman though outside Europe and America was a part of the international scientific community. Raman's deep contacts with the Hungarian Scientific Community began due to Ortvay's visit to India in the middle of the 1930s and continued for the following three decades. These contacts brought the two scientific academies closer.

Raman's lecture based on reminiscence on the discovery of the Raman effect delivered in Hungary has some contradictory statements to the publications in *Nature*. This indicates that the sources based on reminiscence need careful evaluation by the historians.

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Dr. Miklós Molnár – University of Szeged. I acknowledge this help with pleasure. Thanks are due to Churchill Archive Cambridge for Born-Dirac-Ortvay correspondence; Niels Bohr Archive, Copenhagen for Hevesy-Meyer letter; Science Museum London Library for Hevesy-Rutherford correspondence. Also, I acknowledge the help of Raman Research Institute Library staff that send me Rudolf Ortvay's articles published in *Current Science*. Last but not least, my sincere thanks are due to the anonymous referee for valuable comments (which I tried to incorporate as far as possible); and the Journal's copy-editor for editorial work.

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17. It seems that in the late 1920s Raman had close contacts with Stefan Meyer, who was working in the Radium Institute, Vienna. In one of his letters, Raman once recommended a candidate named Karl, who was in India and worked under Raman at the Indian Association for the Cultivation of Sciences, Calcutta. Karl was interested to work on chemical effects of bombarding substances with high velocity (C.V. Raman to S. Meyer, letter Oct. 1, 1928).
18. H. Levi, *George de Hevesy – Life and Work*, Rhodos, Copenhagen, 1985, p. 75.
19. *Twenty-sixth Annual Report (Session 1934-35) of the IIS*, Bangalore, p. 5.
20. George de Hevesy to James Franck, letter July 20, 1934.
21. Not only Hevesy, but also Victor Moritz Goldschmidt (1888-1947), a German mineralogist and geo-chemist, who was in Göttingen until 1935 and was

supposed to guide the researches in the organic chemistry did not come to India, and accepted a Professorship at the University of Olso (*Minutes of the Council IIS*, March 16, 1936, p. 3). Born's letter to Rutherford tells an entirely different story, namely Goldschmidt was interested to spend 1-2 years in India, but the Council of IIS turned down his application. Max Born to Ernest Rutherford, letter Oct. 26, 1936.

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31. M. Born to P.A.M. Dirac, letter May 23, 1936.

32. C.V. Raman to R. Ortvay R, letter Dec. 22, 1936.

33. C.V. Raman to R. Ortvay, telegram dated Jan. 7, 1937.

34. R. Ortvay R to P.A.M. Dirac, letter Jan. 3, 1937.

35. R. Ortvay R to P.A.M. Dirac, letter March 27, 1937.
36. According to the official record Raman was elected on November 21, 1937. See, F. Gézáné (Editor), A *Magyar Tudományos Akadémia Tagjai 1825-1973*, HAS Library Edition, Budapest 1975, p. 520;.
37. C.V. Raman to R. Ortvay, letter June 24, 1937.
38. Ibid.
39. See WWW.mta.hu/, Oct. 12, 2001.
40. First time Raman visited Hungary before the Second World War. See, C.V. Raman, Science in Eastern Europe: I, *Current Science*, 27 (1958) 371-375.
41. Ibid.
42. Professor Laszlo Szalay is the same person who looked after Raman during his visit to Hungary in 1958. See, ref. 40.
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45. C.V. Raman & K.S. Krishnan, 'A new typeof secondary radiation', *Nature*, 121 (1928) 501-502.
46. C.V. Raman, 'A change of wave-length scattering', *Nature*, 121 (1928) 619.
47. It seems Raman was not aware that he was nominated by C. Farby (France) and N. Bohr (Denmark) in 1928. See Rajinder Singh and Falk Riess, 'C.V. Raman, M.N. Saha and the Nobel Prize for the year 1930', *Indian Journal of History of Science*, 1999 (34) 61-75; Rajinder Singh and Falk Riess, 'Sir C.V. Raman and the story of the Nobel Prize', *Current Science* 75 (1998) 965-971; F. Aaserud, "I know how little I have deserved this ...", (in: *Neighbouring Nobel – the history of thirteen Danish Nobel prizes*, Eds. H. Nielsen & K. Nielsen), Aarhus University Press, Aarhus, 2001, pp. 272-312.
48. See ref. 45.
49. See ref. 46.
50. I. Rusznyáak I to C.V. Raman CV, letter Feb. 1, 1962 (Lib. HAS).
51. C.V Raman to H. Jánoshoz, letter Aug. 14, 1963.