My Erdős social numbers and links to world leading scientists by D.L.Shepelyansky Novosibirsk-Toulouse (dated September 14, 2020)

Fig.1 Novosibirsk State University in winter 2004 (photo by DLS)

I. INTRODUCTION

The Erdős number [1] describes the "collaborative distance" between Paul Erdős [2] and other mathematicians measured by authorship of mathematical papers. The idea of the Erdős number was originally launched by friends of Erdős as a tribute to his enormous scientific output. The Erdős number

is assigned to a coauthor of a research paper with another person who has a finite Erdős number k. Paul Erdős has number k=0. The Erdős number of a scientist is k+1 where k is the lowest Erdős number of any coauthor. My real Erdős number should be very high since there not so many joint publications between physicists and mathematicians. However, this concept can be generalized to other type of links between scientists. Thus, here I consider the generalized Erdős social (or scientific distance) number (ESN) defined by a number of links between two specific scientists. The link is established when one scientist personally knows another one. With the development of social networks (see e.g. [3]) such a generalization seems to be rather natural. Here I present my own ESN values with links to the world leading scientists.

In short about myself: was born in Novosibirsk, Russia, USSR (1956), finished the Novosibirsk school number 10 (1973), did my studies at the Novosibirsk State University in physics (1973-1978; see Fig.1), worked at the Institute of Nuclear Physics - INP (1977-1991-1998; now it is Budker Institute of Nuclear Physics - BINP) in the theory group of Boris Chirikov (my teacher and thesis advisor) [4], from 1991 working at the CNRS theory laboratory at Universite Paul Sabatier (Toulouse, France).

II. Erdős social numbers and links

On a first glance it seems that with early studies and work in a far Siberia it is difficult to have short links to any famous scientist. However, the reality is rather different. On the fist year of University I followed the philosophy seminar of Yuri Rumer (Moscow 1901 - Novosibirsk 1985) [5] who was a professor at our University (during my first semester Oct - Dec 1973). He also gave us the lectures on thermodynamics

in the second semester (Jan - May 1974) with exams in June (this was his last course of lectures at University). This course [6] was organized in a rather original way with a specific stress on entropy concept. For its illustration Rumer was telling a joke about hares in a closed corral: after its door opening hares are running away with enormous entropy growth. Thus I have ESN =1 with Rumer. The scientists with my ESN=1 are presented in Fig.2.

Fig.2 Photos of Yu.B.Rumer, G.I.Budker, B.V.Chirikov, Ya.G.Sinai
(left to right, photos are from [7], BINP, DLS-Scholarpedia, Wikipedia; my ESN=1)

During the years 1927-1932 Rumer worked in Germany being an assistant of Max Born at the University of Gottingen. This was the period of foundations of quantum mechanics with main leading physicists visiting Gottingen. The reminiscences of Rumer about this period of his scientific life (as well as other years) are available at [7].

Thus Rumer had contacts and discussions with the pioneers of quantum mechanics including Niels Bohr, Max Born, Paul Ehrenfest, Albert Einstein, Enrico Fermi, Werner Heisenberg, Wolfgang Pauli, Erwin Schrödinger [7]. Thus I have ISN=2 with these scientists. Rumer had especially close relations with Paul Ehrenfest (who was a student of Ludwig Boltzmann at University of Vienna; and he also knew Johann Josef Loschmidt who coined the famous Loschmidt-Boltzamann dispute on time reversibility and statistical description of dynamical motion). Thus I have ESN=3 with Boltzmann and Loschmidt (see Fig.1). Ehrenfest was very close friend of Einstein and he organized a scientific discussion of Rumer, himself and Einstein about ideas of Rumer on a global field theory at home of Einstein in Berlin (see a story of Rumer at [7]).

In 1932 Rumer returned to Moscow, as persecution of Jews in Germany became a real threat to him and his wife. With recommendations of Erwin SchrÃ¶dinger and Leonid Mandelstam Rumer became an associate professor at Physics Department of Moscow State University. Rumer was a close friend of Lev Landau [7] (thus I have ISN=2 with Landau and Mandelstam, see Fig.1). Both Rumer and Landau were arrested arrested in April 1938 as "public enemy of purple". Landau was released after one year after extraordinary efforts of Pyotr Kapitsa and his letter addressed directly to Stalin. While Rumer was kept in jail, worked on plane problem in exile and only in 1948 was allowed to settle in Yeniseysk working as a college teacher of physics and mathematics. Rumer was allowed to move to Novosibirsk in 1950. He worked first at Siberian Branch of Russian Academy of Sciences, became a director of Radio Physics and Radio Electronics Institute in 1957, which was merged into the Semiconductor Physics Institute in 1964. In last years Rumer was a researcher at the theory division of Institute of Nuclear Physics. In 1978 - 1985 his office was on

a distance of about 6 meters from mine, however, Rumer visited his office very rarely working mainly at home.

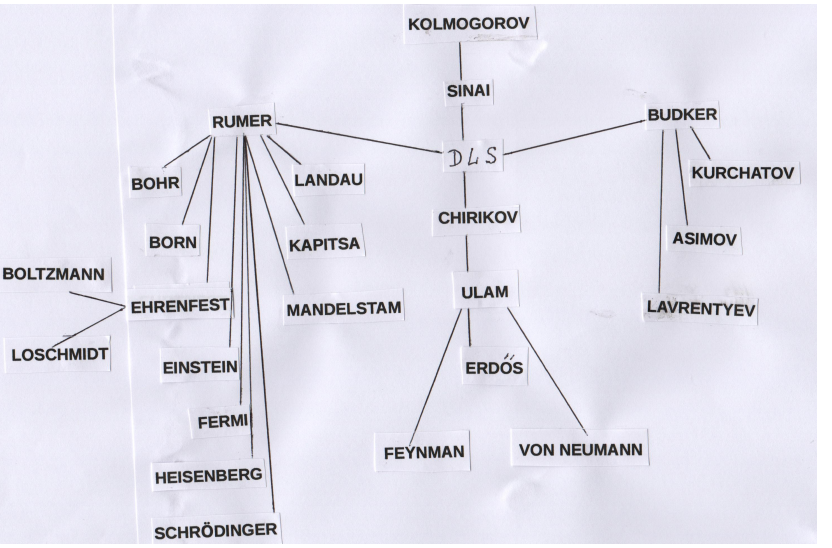

Fig.3 Network of author (DLS) Erdős social numbers and links (ESN).

Of course, many physics students of my University followed lectures of Rumer. But not so many followed his philosophy seminar and moreover not so many of them understood what a world scientist they had in front of them. Also I am proud that some of my works are related to works of Bohr, Ehrenfest, Einstein and Landau (see e.g. [8,9]) to whom I am linked via Rumer with ESN=2. Definitely Rumer knew many other leading scientists (e.g. Andrey Kolmogorov, Mikhail Lavrentyev at Gottingen, Pyotr Kapitsa at Moscow and many others [7]; above I listed only the main part of them, see also links discussed below).

Andrey Mikhailovich (Gersh Itskovich) Budker (1918 - 1977) [10] was the Director of INP. He was giving a special course on high energy and accelerator physics at my fourth year of University in 1977 for a group of students assigned to INP. These lectures were taken place at INP. Budker was rather busy with INP things and often he was replaced by his close collaborators. However, when he was present he was telling fascinating things not only about physics but also people he

knew or met including even his meeting with Isaac Asimov at New York (at one of his lectures he even told us in short a story of Asimov "JOKESTER" [11]). Thus I have ESN=1 with Budker. Of course, Budker knew Igor Kurchatov, who was his advisor and teacher. He also was in contact with Mikhail Lavrentyev, the founder of Akademgorodok. This gives my ESN=2 with Kurchatov, Asimov, Lavrentyev (I do not list here many other scientists and people known to Budker).

I came to a small group of Boris Chirikov in the Theory Division of INP in the fall of 1976 at the beginning of my 4th year of University. He was my teacher, advisor and my scientific discussions and collaboration with him continued till his last year 2008. We wrote 20 joint scientific articles (see [12]). My reminiscences about the pioneer of chaos Boris Chirikov are available at [4] and [13]. Chirikov visited Kolmogorov at his home in 1958 presenting his criterion of chaos in Hamiltonian systems (see [13]) and after he continued to keep close contacts with Arnold and Sinai who were purples of Kolmogorov. Even being in a far Siberia Chirikov was known world wide with many scientific contacts, meetings and visits. Of course, Chirikov knew many well known scientists in physics and mathematics (including Budker, Kurchatov, Kolmogorov, Lavrentyv) but here I note only his meetings with Stanislaw Ulam [14] that took place at a conference in Sweden around 1960 and at the Mathematical Congress in Moscow in 1966 (see [4],[13] and Refs. therein). Thus I have ESN=2 with Ulam and ESN=3 with his friends Paul Erdős, John von Neumann and Richard Feynman [14] (see Fig.3).

In the spring of 1980 Chirikov proposed that I visit Yakov Sinai and Viktor Maslov at Moscow. My first meeting with Sinai [15] was at his home that it rather usual for mathematicians. I described my results on quantum evolution of classically chaotic systems and Sinai

recommended me to Maslov who was a leading expert in quasiclassical methods (I visited Maslov at his dacha and gave a seminar in his group). My meetings with Sinai were rather rare but always useful and stimulating (Gorkov school on nonlinear waves, celebration of 65th birthday of Chirikov, meeting at Princeton 1994 and celebration of 70th of Chirikov in Toulouse in 1998). At the celebration of Chirikovâ€™s 65th birthday, Sinai proposed a special toast for Chirikov and his respect for, and links to, mathematicians. Indeed, Chirikov was able to understand the formal mathematical theorems but tried always to extract their physical meaning, and applied them in his own research. I remember how Chirikov was telling me â€œOf course, itâ€™s usually very difficult for a physicist to read and understand a mathematical paper, but when you corner a good mathematician, like Arnold or Sinai, and discuss closely his results then, he will start to explain them to you as a physicist!â€. Thus I have ESN=1 with Sinai and via him ESN=2 with Kolmogorov (see Fig.3, there are also my links to Kolmogorov via Chirikov and Rumer which are not shown in this Fig.).

III. Scientific works linked to my ESN

Above I described my Erdős social links to the world leading scientists. Somehow it happens that many of my articles [12] are also linked to their scientific results. Below I describe in short some of these articles related to results of scientists from Figs.2,4,5.

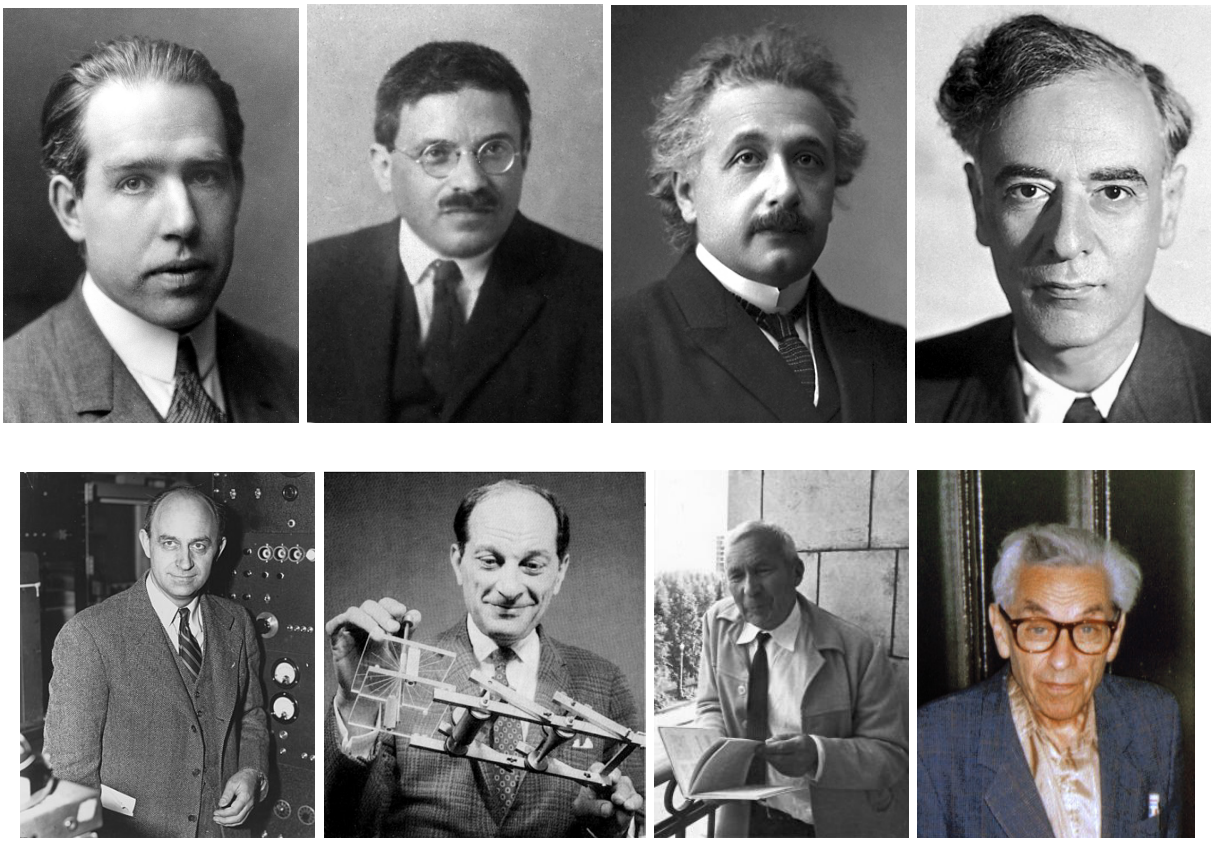

Fig.4 Photos of N.Bohr, P.Ehrenfest, A.Einstein, L.Landau (top, left to right), E.Fermi, S.Ulam, A.Kolmogorov, P.Erdős (bottom, left to right); taken from Wikipedia (my ESN=2 and 3, see Fig.3)

Rumer: The problem of dynamical thermalization in finite many-body systems (classical and quantum) in absence of any links to a thermostat are addressed in [16,17,18,19,20]. For the quantum many-body fermionic system the conditions for thermalization induced by two-body interactions are found. These results are related to the Rumer course of thermodynamics at my first year of University (see [6]), even if this link may be considered as not very direct.

Budker: Chirikov described the Budker problem about particles confinement in open mirror trap [21,22]. The description of this problem was reduced to the Chirikov standard map [21,22] which properties were investigated by Chirikov and me in various articles (see [23] and Refs. therein), even if this link may be considered as not very direct.

Chirikov: being my teacher and advisor he profoundly influenced my scientific research with our 20 joint articles (see [12]) and much beyond that.

Sinai: With my collaborators we introduced the Sinai oscillator (two-dimensional oscillator with an elastic disk placed close to its center) and studied classical and quantum chaos and also dynamical thermalization of fermionic cold atoms in this system (see [19,20] and Refs. therein). Of course the concept of Kolmogorov-Sinai entropy is used and studied in my many other articles.

Bohr, Ehrenfest, Einstein: The problem of Bohr correspondence principle and Ehrenfest theorem for systems with dynamical chaos in the classical limit is analyzed in my several articles (see [24] and Refs. therein). Already in 1917 Einstein pointed on the problem of semiclassical quantization of nonintegrable systems (now we say chaos), which are generic according to the result of Poincaré. The dynamical thermalization of a Bose-Einstein condensate in a Sinai-oscillator trap is described in [19].

Landau: The problem of chaotic Landau level mixing in classical and quantum wells is analyzed in [25]. The Landau effect for interactions of particles in a vicinity of the Fermi level (Landau-Fermi liquid) is analyzed in the frame of dynamical thermalization in finite Fermi systems in [16,20].

Fermi: The dynamical thermalization in finite Fermi systems is studied in [16,17,20]. The low energy chaos in the Fermi-Pasta-Ulam problem (1955) is analyzed in [26].

Ulam: As for Fermi, the linked article is about low energy chaos in the Fermi-Pasta-Ulam problem (1955) [26]. However, there are more links with the articles about the Ulam networks obtained by the Ulam method for dynamical chaos maps (see [27,28] and Refs. therein). In [28] various

results for the Google matrix of directed networks are described in detail.

Kolmogorov: The interlinks between the Kolmogorov turbulence, Anderson localization and Kolmogorov-Arnold-Moser integrability are described in [29,30[.

Erdős : The articles directly related to the Erdős numbers are [31,32]. These articles are also linked to black hole models, complex directed networks and PageRank algorithm of Google search engine (see [28] for the latter).

Fig.5 Postage stamps of L.Boltzmann, J.Loschmidt
(left to right; my ESN=3 from Fig.3)

Boltzmann, Loschmidt: The famous Loschmidt-Boltzamann dispute (1876-1877) about entropy growth, dynamical equations of motion leading to statistical description and breaking of time reversibility of dynamical time-revers-able equations is directly related to dynamical chaos and its exponential instability of motion as discussed at [33] and other articles (see [23] and Refs. therein).

This is a short description of my scientific links on my Quantware science pathway (see Fig.6) from Novosibirsk to Toulouse and beyond ...

Fig.6 Quantware pathway along Canal du Midi at Toulouse and beyond

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