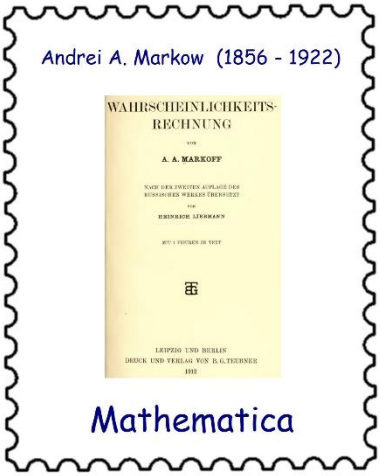
ANDREI A MARKOV (June 14, 1856 – July 20, 1922)

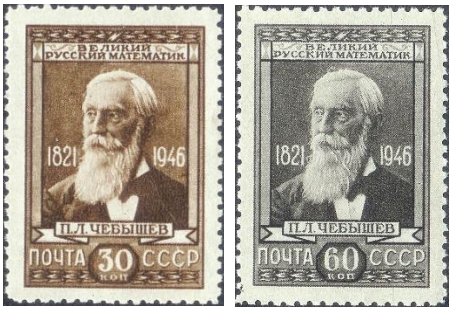
by HEINZ KLAUS STRICK, Germany



ANDREI ANDREYEVICH MARKOV's birthplace was Ryasan, an administrative centre of a region located about 200 km southeast of Moscow. His father, ANDREI GRIGORIEVICH MARKOV, worked for the state forestry administration. When he was offered a job as an estate manager in St Petersburg, he moved with his young family to Russia's capital.

In his first years of life, ANDREI suffered from considerable health problems. Until the age of 10, he could only walk with the help of crutches.

During his school years, the boy was already noticed for his exceptional talent in mathematics. At the age of 17, he wrote a paper on the solution of linear differential equations, which he presented to two mathematics professors at the university, ALEXANDER NIKOLAYEVICH KORKIN and IGOR IWANOWITSCH ZOLOTARJOW. Although the procedure presented by ANDREI was not new, the investigation was remarkable as an independent achievement, and from then on the student was allowed to participate in KORKIN's Saturday seminars, which he regularly offered to his students.



At the age of 18, ANDREI MARKOV was finally able to attend university. In addition to the lectures of KORKIN and ZOLOTAREV, he also attended those of the head of the institute PAFNUTY LVOVICH CHEBYCHEV, whose suggestions for his own independent investigations were gladly taken up by MARKOV.

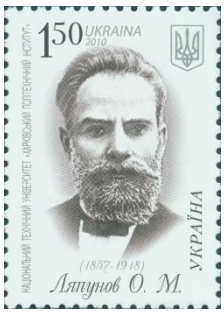
After four years, he passed his exams, having already won a gold medal from the faculty the year before with a thesis on the subject of *On the Solution of Differential Equations with the Aid of Continued Fractions with Application to* $(1+x^2)\cdot y' = n\cdot(1+y^2)$.

In 1880 he received his doctorate with a thesis on number theory. Although this paper was promptly translated into French and published in the *Mathematische Annalen*, 30 years passed before Western European mathematicians began to deal with the profound discoveries it contained.

After his doctorate, MARKOV lectured on analysis at the university as a private lecturer and at the same time he worked on his *habilitation* thesis.

In 1883 he married his childhood sweetheart MARIA IVANOVA VALVATYEVA. She was the daughter of the landowner whose estates were administered by MARKOV's father. He had taught her mathematics and proposed to her at an early age. However, her mother opposed the "unsuitable" marriage. Only when his appointment as a university professor was imminent did she agree. The marriage produced only one child: a son (with the same first name as his father) who later became a professor of mathematical logic at Moscow University.

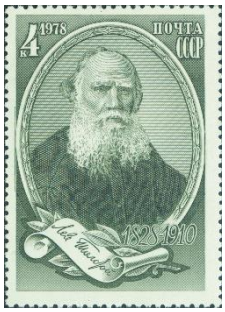
In 1886 MARKOV was appointed associate professor at St Petersburg University and at the same time nominated as a candidate of the *Russian Academy of Sciences* (from 1896 as successor to CHEBYCHEV). He only held a full professorship between 1896 and 1905. However, he continued his teaching activities for many years after his official retirement.



MARKOV's publications show his many-sided interest. In particular, he investigated under which conditions, as general as possible, the *law of the large numbers* or the *central limit theorem* apply, and thus – together with ALEXANDER MIKHAILOVICH LYAPUNOV – continued the work of his highly revered teacher CHEBYCHEV.

MARKOV's *Probability calculus* was published in four languages with a total of 29 editions and his *Method of least squares* was reprinted nine times.

At the turn of the century, a heated argument developed with his Moscow colleague PAVEL ALEXEYEVICH NEKRASSOV, who had originally studied theology and applied his orthodox religious-philosophical views to probability theory. NEKRASSOV saw parallels between a person's free will and independent events in probability theory. According to his conviction, the *law of large numbers* was only applicable to independent random variables. The stabilisation of relative frequencies in crime statistics, for example, proved that the underlying decisions were made by free will and independently of each other.



MARKOV, on the other hand (who left the Church in 1901 when the Orthodox Church excommunicated LEO TOLSTOY), assumed that the *law of large numbers* also applied to dependent variables under certain conditions.

With the theory of stochastic processes which he developed – later called *MARKOV chains* in his honour – he opened up a new branch of probability theory. In contrast to the random experiments usually considered up until then, which were based on certain fixed probabilities, he was interested in processes in which the probability of the occurrence of a certain event depended on which event had occurred last.

These random processes could be described with the help of *transition probabilities*, i.e. the probabilities with which the change from a previous "state" to the current "state" occurred, and with this he then drew conclusions about future "states". Step by step, he also succeeded in proving that long processes led to a stabilisation of the relative frequencies for the individual states.

As an example of such a process, MARKOV examined the sequence of consonants and vowels in a famous literary work.

He evaluated the first 20,000 letters (i.e. without punctuation marks and spaces) of ALEXANDER SERGEYEVICH PUSHKIN's verse novel *Eugene Onegin* (published in 1833). The text excerpt contained 43.2 % vowels and 56.8 % consonants. He then divided the characters into 200 blocks, each with 10 rows and 10 columns, and determined the number of consonants and vowels for each row and column, as well as the mean and dispersion of this frequency distribution. He also counted the pairs of consecutive letters: In 19.1% of the pairs, two consonants followed each other, in 5.5% two vowels.

If PUSHKIN's text were subject to the principle of independence, then the product theorem for probabilities would have to be applicable. However, it turned out that, for example, the proportion of *vowel-vowel pairs* was not $0.432^2 \approx 0.187$, but only about one third of this. MARKOV also examined successive triples of letters as well as the text of another Russian writer.

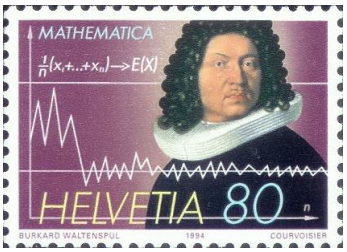
MARKOV's publications initially received little attention. Today, modelling with the help of MARKOV chains plays a major role in numerous sciences.

The mathematical foundations created by MARKOV were later developed into a general theory by ANDREI NIKOLAYVICH KOLMOGOROV.

(This millennium stamp from Portugal shows JULES HENRI POINCARÉ, KURT GÖDEL and ANDREI KOLMOGOROV as the most important mathematicians of the 20th century).

In 1902, the writer MAXIM GORKI (real name: ALEXEI MAXIMOVICH PESHKOV) was elected as a member of the *Russian Academy of Sciences*. However, the election of the left-wing activist was annulled at the behest of the Tsar. MARKOV protested vehemently against this intervention by the ruler in the institution's decision, and when he was to be honoured by the Tsar the following year for his special services to Russian science, he refused the honour as a sign of his protest.

In 1907 Tsar NIKOLAUS II dissolved the legislative assembly, the *Duma*, because – after a free election – left-wing groups had gained a majority. MARKOV then publicly declared his resignation from the *Academy*. This step, however, had no consequences.



When in 1913 the ROMANOVs celebrated the 300-year reign of their dynasty on the Tsar's throne with great pomp, MARKOV set another anniversary against it: he celebrated 200 years of the *Law of Large Numbers*, in memory of JACOB BERNOULLI's *Ars Conjectandi*, published posthumously in 1713.

After the outbreak of the Russian Revolution, MARKOV took on a job – without pay – as a mathematics teacher in the provinces on behalf of the *Academy of Sciences*. After returning to (the renamed) Petrograd, his health deteriorated and, although barely able to keep himself upright, he temporarily resumed his lectures on probability theory at the university, but succumbed to his ailment a few months later.

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Here an important hint for philatelists who also like individual (not officially issued) stamps.