http://www.youtube.com/watch?v=hvYoGl7KPY8

... one of some dozen Russian movies on Lomonosov
Reflections on the Nature of Genius on Occasion of 300th Anniversary of Mikhail Lomonosov (1711-1765)

Which are the most complex sciences of nowadays? How the Chinook-47D helicopter came out of atmospheric electricity studies? What is the difference between “Type A” and “Type B” geniuses? How mosaics and the finest European porcelains are related to the law of conservation of matter? Whom does Benjamin Franklin meet in the downtown Batavia? Why observation of the Venus’s atmosphere during its transit over Sun’s disc on June 5, 2012 will be as hard as in May 26, 1761 when it was discovered? How many people are needed to reform a grammar, to invent a new type of reflector telescope, to estimate the age of the Earth to be at least 399,000 years on base of scientific evidences, a perform more than 4000 chemical tests in the Russia’s first national laboratory, organize unprecedented Arctic exploration expedition and win a public completion among three best national poets? What is in common between Bob Wilson and Michelangelo Buonarotti? All that and much more in the lecture on the occasion of the 300th anniversary of the titanic figure of Russian Enlightenment – Mikhail Lomonosov (1711-1765). You are welcome to attend for a chance in just under 60 minutes to become one of only a few hundred Americans most knowledgeable in the achievements of a true Russian genius.
Lomonosov - 300

• Who is Lomonosov
• Timeline of His Life
• His Contributions to Science
• Complexity of Science
• What Does Make a Genius?
Mikhail Vasil’evich LOMONOSOV
Nov 19, 1711 – Apr 15, 1765

- Physicist and Chemist
- Poet and Artist
- Engineer and Entrepreneur
- Courtier and Administrator
- Philologist and Astronomer
- Geologist and Mineralogist
“Passionary Power” of Russian Ethnos

Power (a.u.)

1700  1750  1800  1850  1900  1950  2000

Lomonosov Tercentennial
“...between Peter I and Catherine II, he (Lomonosov) was the original champion of the Enlightenment. He founded the first University: better to say, he himself was our first University...”

А.С.Пушкин 1835

“...между Петром I и Екатериной II он один является самобытным сподвижником просвещения. Он создал первый университет; он, лучше сказать, сам был первым нашим университетом”

A.С.Пушкин 1835
Named After Lomonosov

- **Moscow State University** – Russian “Number One”
- **Town (near St. Petersburg)**, home village in the North Range in Arctic ocean, ocean stream, peninsula, Moon crater, mineral, crayfish species
- Three other Universities
- One Theater
- **Russian State Porcelain Factory**
- **8 Schools**
- **54 streets and squares**
- Russian State-wide Tercentennial celebration in 2011
Roots & Early Life

1711-1730

1730-1736
School & Scientific Tradition

Gottfried Wilhelm von Leibniz
1646 – 1716

Christian Wolff
1679 - 1754

Mikhail Lomonosov
1711 - 1765

Lomonosov Tercentennial

In Germany
1737-1741
Lomonosov: 23 years in St.P’s Academy

- **Adjunct Professor** of Physics St.Petersburg Academy 1742
- Dissertation “On origins of heat and cold” 1745
  (refereed and strongly supported by Leonhard Euler)
- **Academician** (Professor) of St.Petersburg Academy 1745
- Formulation and experimental proof of law of 1748
  conservation of matter and movements
- Physical Chemistry 1752
- *Measurements* of atmospheric electricity and 1753
  theory of electricity (with G.Richmann)
- First working model of helicopter 1754
- Novel concept of Reflector telescope 1756
- Theoretical concept of Earthquakes’ origin 1757
  of minerals, review of geological observations
- Solid mercury obtained & studied (with I.Braun) 1759
- Discovery of Venus atmosphere 1761
- Theoretical justification of the Arctic path expedition 1763-65
Scientific Academies

• Platonic Academy in Athens ~380’s BC
• Accademia dei Lincei 1603
• Royal Society of London 1660
• German Academy of Sciences Leopoldina 1662
• French Academy of Sciences 1666
• Prussian Academy of Sciences Berlin 1700
• St-Petersburg Academy of Sciences 1724
• Royal Swedish Academy of Sciences 1739
• American Philosophical Society 1743
• Göttingen Academy of Sciences 1751
• Dutch Academy of Arts and Sciences 1806
• Academie Des Sciences Wien 1847
• National Academy of Sciences USA 1863
Saint-Petersburg Academy

fully sponsored by the state (poll-taxes from 3 towns)

1724

Lomonosov was the 1st Russian Academician (1745)

- Imperial Academy of Sciences 1747
- Russian Academy of Sciences 1917
- USSR Academy of Sciences 1925
- Russian Academy of Sciences 1991
6 volumes out 11 on Natural Sciences: Physics, Chemistry, Astronomy, Geology, Geography
Lomonosov’s Method

• He was [a Thinker + an Experimenter] :
  – His theories and hypotheses were based on tests and experiments, which he planned, prepared and carried out himself.

• He used to work on each of his many research topics for many years if not decades

• Always tried to turn his scientific discoveries into practice or inventions
Lomonosov’s Major Results (1)

• New science of *Physical Chemistry* (1752)
  – on base of corpuscular-mechanical view
  – theory of light and color
  – the concept of *absolute cold*

• Experimental proof of the law of conservation of matter:
  – the amendment to R. Boyle

• Experiments on the freezing of mercury
  – with I. Brown
His Corpuscular-Mechanical Views

- Heat is not a liquid, it is a measure of rotation and motion of molecules
- Concept of absolute cold – no rotation or motion
- (out of fashion 1760-1840)

\[ P = \frac{RT}{(V-b)} \]

R. Clausius 1850’s

Figs. 1-3
Chemical-Physical Laboratory

- Russia’s first national research lab
- Senate granted 1500 rubles
- >4000 tests by himself!
- Famous test in 1756
  - Repeated by Lavoisier 1773
R. Boyle 1673: lead weight increased after heating (vessel opened) → “caloric particles penetrated glass”

Lomonosov 1756: lead weight remained the same when vessel sealed → no caloric particles, matter conserved (in chemical reaction):

“...all changes that we encounter in nature proceed so that... however much matter is added to a body, as much is taken away from another ... since this is the general law of nature, it is also found in the rules of motion: a body loses as much motion as it gives to another body”.

letter to Leonhard Euler
Mercury is Metal!  January 1759

• Cold weather -26 C
• Used mix of snow and concentrated nitric acid
• Together with I.Braun
  – Report Royal Society
  – Priority battle with F.U.T.Epinus
Mosaics “Battle of Poltava” (1764)
Lomonosov’s Major Results (2)

• Electricity studies 1745-1760’s
  – first quantitative measurement of electricity
  – Two measuring instruments (scales and electrometer) - with G. Richman
  – Automatic “lightning-meter” proposal
  – helicopter for atmospheric research

• The theory of air electricity
  – The friction in the vertical air currents
  – Applied to Northern Lights/ auroras

• Color theory in electric discharge
Lomonosov’s Electrostatic Experiments

death of Georg Richter

07/26/1753

Richman electrometer
Air density increase due to lower temperature in upper atmosphere is ~2.5 times stronger than density decrease due to high elevation.
1754 Lomonosov’s “Aerodynamic Machine”

Chinese top 4th cent. A.D.

Leonardo’s “airscrew” 1493

* counter-rotating blades
**for atmospheric research
Chinook CH-47D

also in Yak-24, Piasecki H-21, all Kamov’s helicopters
Lomonosov’s Major Results (3)

• Discovery of atmosphere of Venus
  – during the 1761 Transit of Venus

• Inventions
  – A telescope with one lens (”Herschellian”)
  – Sideroscope
  – “Night-vision tube”
  – Method to determine the position of the sun on the ship
  – Automatic course recorder of a ship
  – Many others
1761 – 176 observers at 117 stations (including 5 Russian astronomers in 3 cities all over Russia); major goal – determine distance to the Sun; very rare event – ToV in 1769, 1876, 1884 and 2004 ...
Lomonosov’s Actions in 1761

Important! – he used lightly smoked glass

1762 telescope by Lomonosov
Lomonosov Discovery of Atmosphere of Venus

Atmosphere $\rightarrow$ “life” $\rightarrow$ humans $\rightarrow$ “christians?”
Very latest on Venus “life forms”

Analysis of panoramic images of “Venera-9, 10,13,14” (1975 & 1982)

Transit of Venus June 6, 2012

You can see it, your kids can see it, your neighbor kids can see it!

Figure 3 - World Visibility of the Transit of Venus — 2012 June 06

250th Anniversary of the Discovery of Venus Atmosphere by Lomonosov
Lomonosov Inventions (1)

I. Newton 1668

M. Lomonosov 1756
W. Hershel 1789
Night-Vision Tube 1756

- Large objective + 8mm eye-piece
- 3 built for Arctic expedition 1765
- MVL’s explanations denied
  - by Epinus, Rumovsky, Grishow
  - *Ricco’s law* 1877: $B_{\text{min}} = \text{const}/\text{Area}$
“Siderostat”

flat mirror

W. Herschel 1789

M. Lomonosov 1759
Lomonosov: Beyond Natural Sciences

• Odes to Empresses  1739, 1746, 1763
• Founded Moscow University  1755
• Arctic Sea Expedition  1763
• Russian Grammar  1754
• Mosaics Factory  1752-1764
• Academy Management (top 3)  1757-1765
• Russian History  1765
• Demography Analysis  1761
  – Age difference (15/2), no forced marriages, 3rd time widowers, monks age limit, baptism in warm water, move holydays, pharmacies, birth assistance → 10 million/20 yrs (pop. 22 million in 1750) double the rate
History of Science in Russia

1700

1750

1800

1850

1900

1950

2000

Lomonosov Tercentennial

e^{i\pi} + 1 = 0
• New culturonomics tool:
  – Frequency of appearance of the word or combination of words in the published books vs year
  – >5M digitized books (5%), 500B words, 7 languages
Three Scientific Geniuses:
English, German, Russian book collections
On the Nature of Scientific Genius

• I will need to guide you through a concept of complexity of sciences which requires a little bit of math
An Example of Complex System: integrated circuits

“Moore’s Law”

number of transistors on one chip doubles every ~2 years
Progress in Complex Systems

The system is complex → many intervened problems and parameters → one can not solve all at once → address problems step by step

Fractional Gain per steps $1 \rightarrow (1 + F)$

after $M$ steps $(1 + F)^M \approx e^{FM}$, etc.

...or performance $L$ grows in time as →

$L(\text{after time } T) = L_0 \times \exp(T/C)$

$C$ (Complexity) = # years to e-fold progress

E.g. “Moore’s Law” → $C=2 \text{ yrs}/\ln(2 \text{ factor})=2.9$
Thermonuclear Reactors

The graph shows the increase in the fusion triple product $T_{n\pi}$ over time, with a factor of $>100,000$ over approximately 30 years. The formula $D + T \rightarrow \text{He}^4 + 14.2 \text{ MeV}$ is also mentioned, indicating the reaction that produces helium and heat.

$C = 2.4$
Exoplanets

C = 4.2

factor ~100 over ~20 years
Number of Observed Galaxies

C = 3.0

factor ~10,000 over ~25 years
Ultra-High Power Lasers

$C = 3.3$

factor $\sim 1000$ over $\sim 25$ years
Protein Structures deposited in PDB

C = 4.2

factor ~1000 over ~25 years
Beam Energy

C\textsubscript{proton} = 4.3

C\textsubscript{electron} = 5.2

factor \sim 10,000,000 over \sim 80 years
<table>
<thead>
<tr>
<th>Topic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supercomputers</td>
<td>1.6</td>
</tr>
<tr>
<td>Fusion Reactors</td>
<td>2.4</td>
</tr>
<tr>
<td>Moore’s law</td>
<td>2.9</td>
</tr>
<tr>
<td>Galaxies Surveyed</td>
<td>3.0</td>
</tr>
<tr>
<td>Laser power</td>
<td>3.3</td>
</tr>
<tr>
<td>Protein structures</td>
<td>4.2</td>
</tr>
<tr>
<td>Exoplanets search</td>
<td>4.2</td>
</tr>
<tr>
<td>Accelerator energy</td>
<td>4.3-5.2</td>
</tr>
</tbody>
</table>
Back to Moore’s Law – Who Started it?

1947 Bardeen, Brattain
“Genius Effect”

\[ D = \ln(\text{After/Before}) \]
To be able to compare historical figures, more useful is:

“Genius Formula”

$$\text{Genius} = T \times B \times D$$

- $\ln(\text{Time})$: duration of impact
- Breadth: # of areas
- Depth: of impact $= \ln(\text{After/Before})$
“B-factor” Scientific Geniuses:

“Type A” and “Type B”

Fields of Science

Log (Impact)

“Type A”:
Euler
Lavoisier
Gauss
Maxwell
Riemann
Mendelev
Pavlov
Mendel
Rutherford
Plank
Einstein
Kolmogorov
Feynman,

“Type B”:
Aristotle
Leonardo
Descartes
Newton
Leibniz
Lomonosov
Franklin
Poincare
von Neumann
<table>
<thead>
<tr>
<th>Subject</th>
<th>Duration (yrs)</th>
<th>Factor</th>
<th>Calculation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grammar</td>
<td>100</td>
<td>ln(2)</td>
<td>$\ln(100) \times \ln(2) = 3$</td>
<td></td>
</tr>
<tr>
<td>Poetry</td>
<td>60</td>
<td>$1/3$</td>
<td>$\ln(60) \times 1/3 = 1.3$</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>20</td>
<td>0.1</td>
<td>$\ln(20) \times 0.1 = 0.3$</td>
<td></td>
</tr>
<tr>
<td>Optics</td>
<td>100</td>
<td>$1/20$</td>
<td>$\ln(100) \times 1/20 = 0.2$</td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td>60</td>
<td>$1/5$</td>
<td>$\ln(60) \times 1/5 = 0.8$</td>
<td></td>
</tr>
<tr>
<td>Geography</td>
<td>60</td>
<td>$1/4$</td>
<td>$\ln(60) \times 1/4 = 0.9$</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>250</td>
<td>$1/10$</td>
<td>$\ln(250) \times 1/10 = 0.5$</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL**  \( G = 7 \pm 2 \)
Genius Coefficients $G = T \times B \times D$

- Scientist(me) $\sim 0.03$
- Great Inventors 0.1-2
- Nobel Laureats 0.3-4
- Aristotle, Galileo, Newton, Lomonosov, Einstein 4-9
- Sheakespeare, Pushkin 7-12
- Biblical God 123
- Big Bang 300-650

$\ln(7519\text{yrs}) \times 6 \times \ln(10)$

$\ln(14\text{BYrs}) \times \ln(10^6)$
~200 sciences

Global Genius Product

GGP ~ (4-10) per year
Other Characteristics of a Genius
Every Genius Has (An Impressive) Story!

Archimedes

Eppur si muove (still it moves)

Newton’s Apple

Mendeleev

Franklin’s kite

Lomonosov Tercentennial
German hussars enlisted drunk Lomonosov to the service of the King of Prussia

Lomonosov’s prophetic dream about his father

Three sailors’ attempt to rob Lomonosov

…fighting and writing!

Hey, he’s a real polymath!
Final Words...

• The system of entire humankind is very complex
  – Both in terms of hierarchy of connections and C-coefficients

• We see that it is progressing, moving somewhere
  – Generates new knowledge, ideas, arts, inventions, etc

• It’s not fully clear yet how world’s genius (GGP - global genius product) is created
  – it is hard to get there, so we should not lose positions
  – advanced society is needed for genius to appear
  – on the other hand, geniuses do transform the society

• To understand who we are, we must comprehend our geniuses of a type of Galileo, Newton, Einstein, Leibniz, Franklin, and Lomonosov
With that –

I congratulate all of us with 300th anniversary of Mikhail Lomonosov!

Thank you for your attention!
Limitations of the “Genius Formula”

\[ G = \ln(T) \times B \times \ln(\text{After/Before}) \]

• how to account geniuses in art, music, etc?

• **Baseline** choice issue
  – eg (my) family of 4 with two kids
  – Using Humankind as the base
    \[ G = \ln(13\text{yrs}) \times 2\text{kids} \times \ln([7B+1]/7B) = 1 \times 10^{-9} \]
  – by (my wife’s) definition
    \[ G = \ln(13\text{yrs}) \times 2\text{kids} \times \ln(4/2) = 3.5 \]
Geniuses
Most Prominent Russian Scientists

Russian book collection

![Graph showing the frequency of appearance of Lomonosov, Mendeleev, and Pavlov in books from 1750 to 2000.](image-url)
John Bardeen $G_i$:

- Invention of transistor 1947 - with Brattain
  \[ \frac{1}{2} \times \ln(65 \text{ yrs}) \times \ln(3) = 2.3 \]

- Theory of Superconductivity 1957 - with Cooper and Schrieffer
  \[ \frac{1}{3} \times \ln(55 \text{ yrs}) \times \ln(1.5) = 0.5 \]

**TOTAL** 2.8
Another Sign of Genius: Rebelliousness

Petr Kapitsa, USSR
1978 Nobel Prize
Superfluid Helium

• Kapitsa On Geniuses:
  – Lomonosov vs Schumacher
  – Michelangelo and Medici
  – Kapitsa himself and Beriya
“...What's in my name for you?”

Pushkin

- **Mikhail** (1\textsuperscript{st} name)
  - Very typical Russian/Slavic
  - Michael
  - Of choice for Nov. 19 DOB

- **Vasil’evich** (2\textsuperscript{nd} name)
  - Father’s name - Vasily
  - “State-peasant” → fisherman

- **Lomonosov** (family name)
  - Two possible meanings →

“Ломоносов” = Clematis

“Ломоносов” = breaking noses
Against Newton’s Corpuscular Theory of Light
Grigory Perelman

proved soul theory of manifolds 1994
declined European Math Prize 1996
proved Poincare Conjecture 2002
declined Fields Medal 2004
declined 1M$ Clay Prize 2010
refused Academy Position 2011

Lomonosov Tercentennial