

<http://www.youtube.com/watch?v=hvYoGI7KPY8>

... 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.

Tercentennial Anniversary of **LOMONOSOV**

Nov 19, 2011



Lomonosov Tercentennial

Lomonosov - 300

- Who is he
- Life
- Science
- Complexity of Science
- What does make a genius?
- Anecdotes
- Then and Now

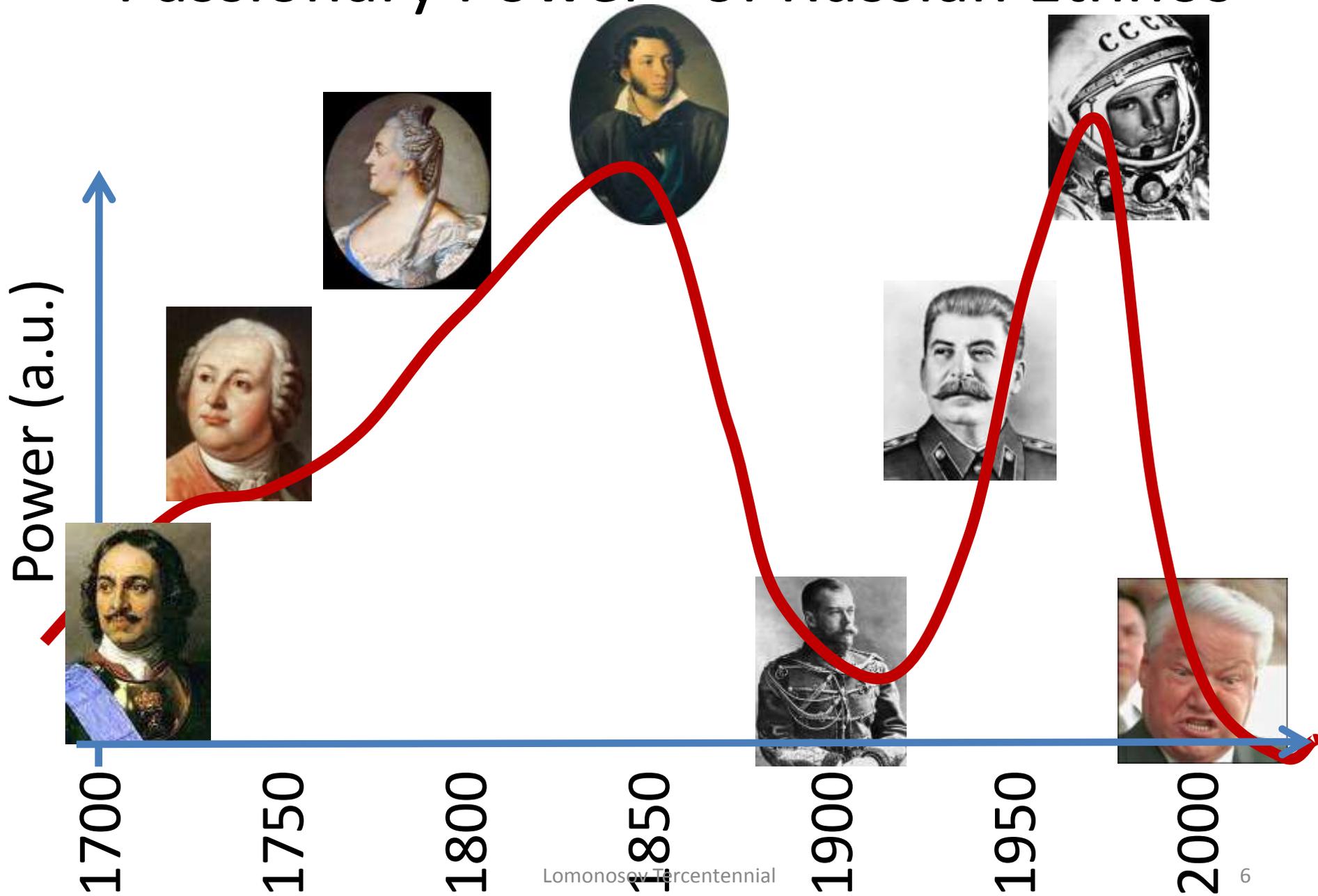
Mikhail Vasil'evich **LOMONOSOV**

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



Lomonosov Tercentennial

Pushkin on Lomonosov

1755

Moscow University



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

А.С.Пушкин 1835



“...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...”

Named After Lomonosov

- **Moscow State University** – the top one in Russia
- **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



“...What's in my name for you?”

Pushkin

- *Mikhail* (1st name)
 - Very typical Russian/Slavic
 - Michael
 - Of choice for Nov. 19 DOB
- *Vasil'evich* (2nd name)
 - Father's name - Vasily
 - “State-peasant” → fisherman
- *Lomonosov* (family name)
 - Two possible meanings →

“Ломонос” = *Clematis*



“Ломоносов” = *breaking noses*

Roots & Early Life



1711-1730



1730-1736



School & Scientific Tradition



Gottfried Wilhelm von Leibniz

1646 – 1716



Christian Wolff

1679 - 1754



Mikhail Lomonosov

1711 - 1765

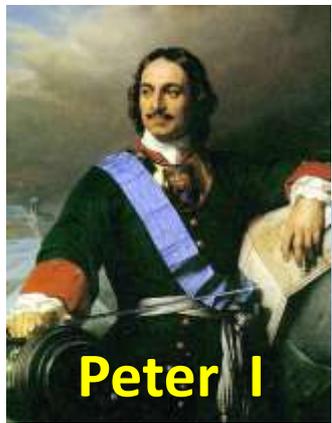
**In Germany
1737-1741**

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 conservation of matter and movements 1748
- Physical Chemistry 1752
- *Measurements* of atmospheric electricity and theory of electricity (with G.Richmann) 1753
- First working model of helicopter 1754
- Novel concept of Reflector telescope 1756
- Theoretical concept of Earthquakes' origin of minerals, review of geological observations 1757
- 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
- Prussia 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



Peter I

Saint-Petersburg Academy

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

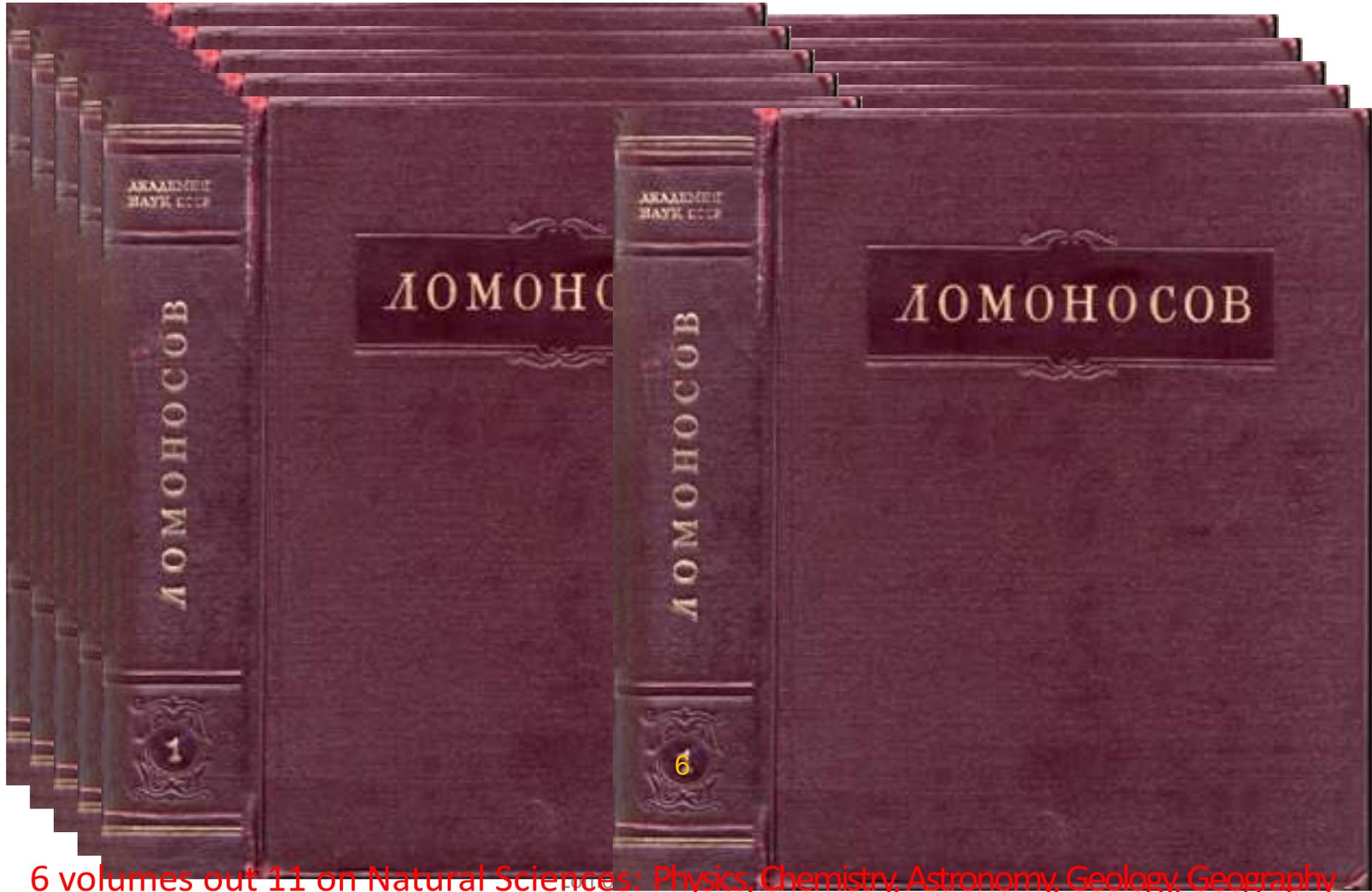
1724



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

Lomonosov *Complete Works* 1950-83



6 volumes out 11 on Natural Sciences: Physics, Chemistry, Astronomy, Geology, Geography

Lomonosov's Method

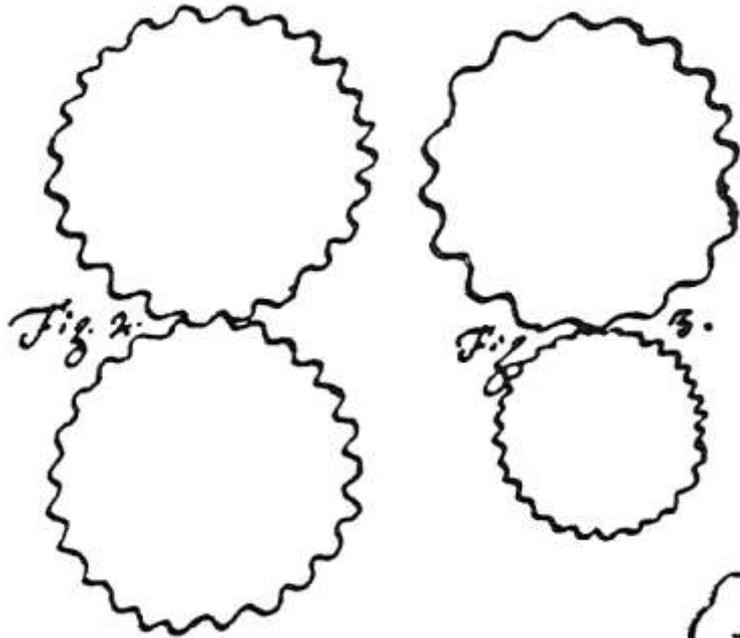
- He was [a Thinker + an Experimenter] :
 - His theories and hypotheses were based on tests and experiments, which he planned, prepared and carried out himself.
- He used to work on each of his many research topics for many years if not decades
- Always tried to turn his scientific discoveries into practice 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

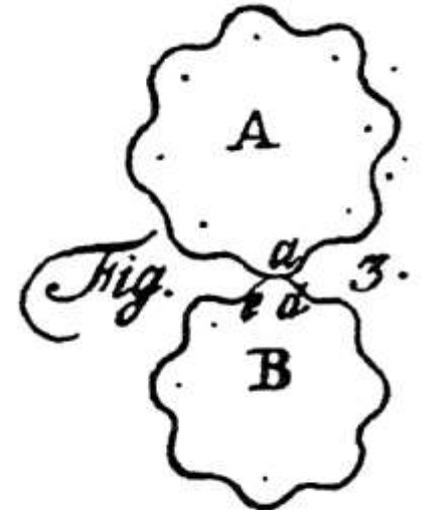
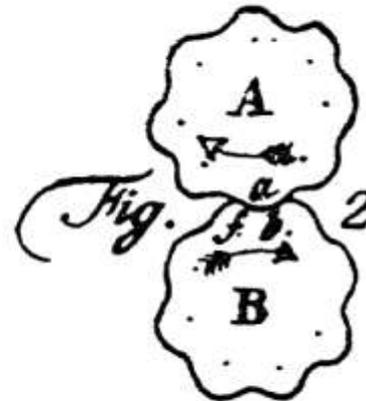
- Heat is not a liquid, it is a measure of rotation and motion of molecules
- Concept of **absolute cold** – no rotation or motion
- (out of fashion 1760-1840)



$R=8.3 \text{ J}/(\text{mole K})$

$$P=RT/(V-b)$$

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

Matter & Motion Conservation

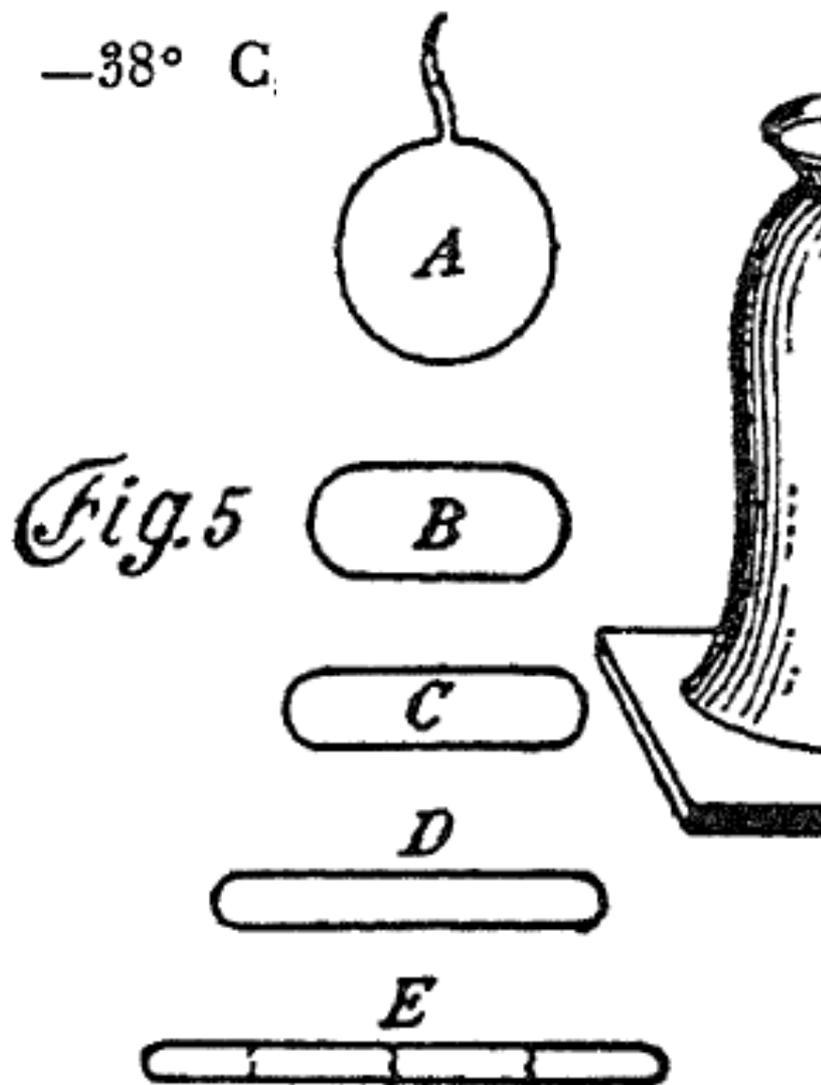


R.Boyle 1673: lead weight increased after heating (vessel opened) → “caloric particles penetrated glass”

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

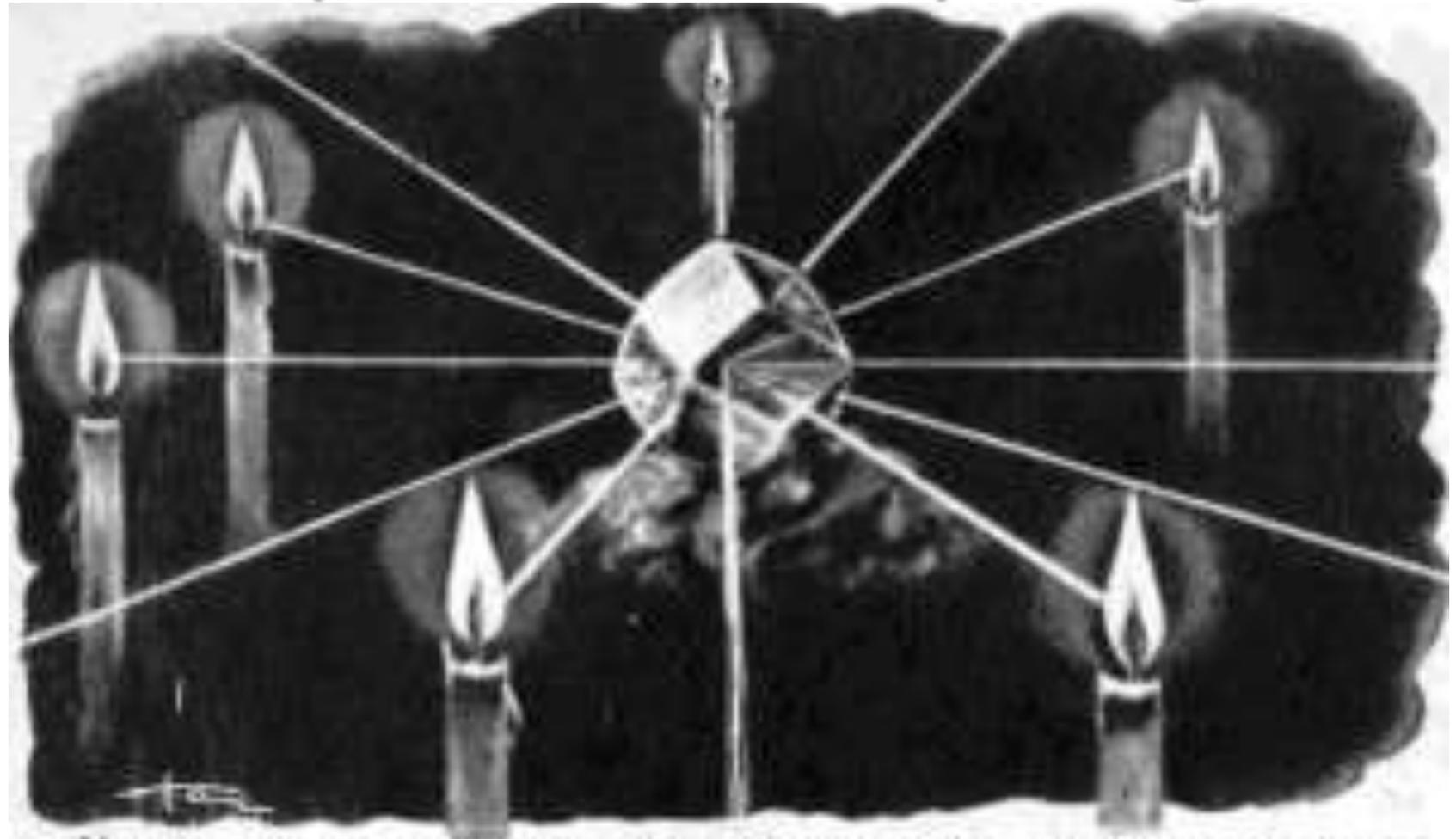
“...all changes that we encounter in nature proceed so that... however much matter is added to a body, as much is taken away from another ... since this is the general law of nature, it is also found in the rules of motion: a body loses as much motion as it gives to another body”. letter to Leonhard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

Against Newton's Corpuscular Theory of Light



Многие современники Ломоносова считали свет потоками очень тонкой материи. «Но если это так, — спрашивал Ломоносов, — то каким образом световые лучи от многих свечей, не сталкиваясь, проходят сквозь щель?»

Mosaics “Battle of Poltava” (1764)



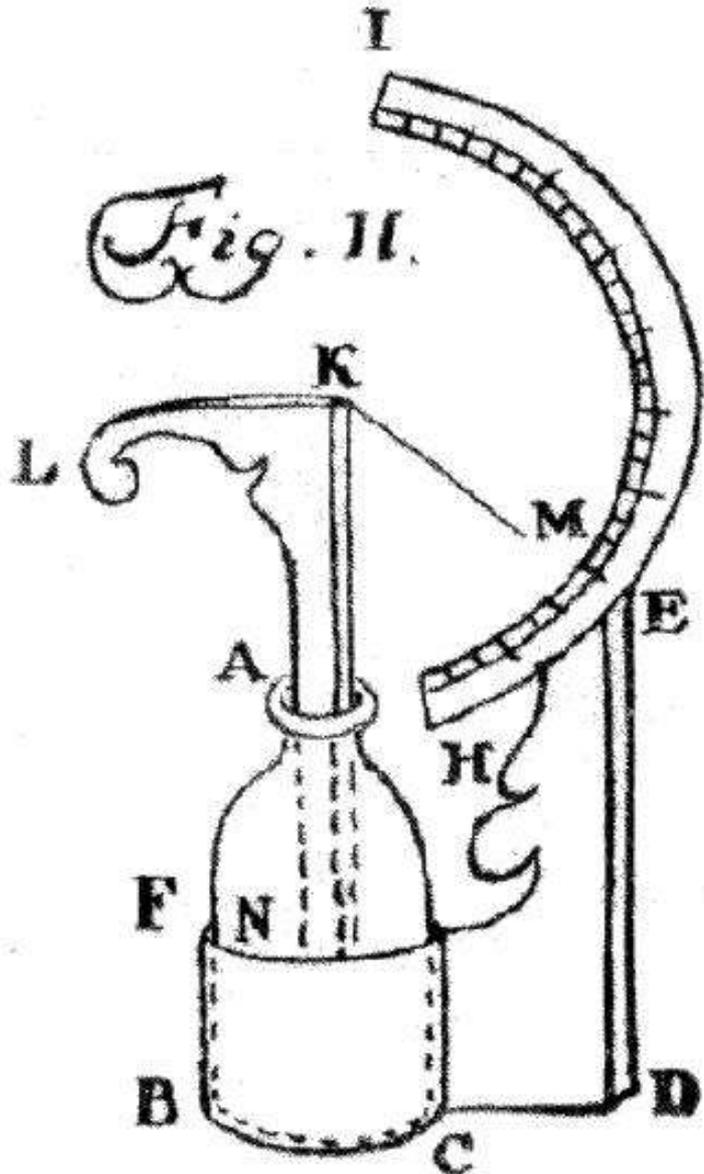
Lomonosov Tercentennial

6.4 x 4.8 m

Lomonosov's Major Results (2)

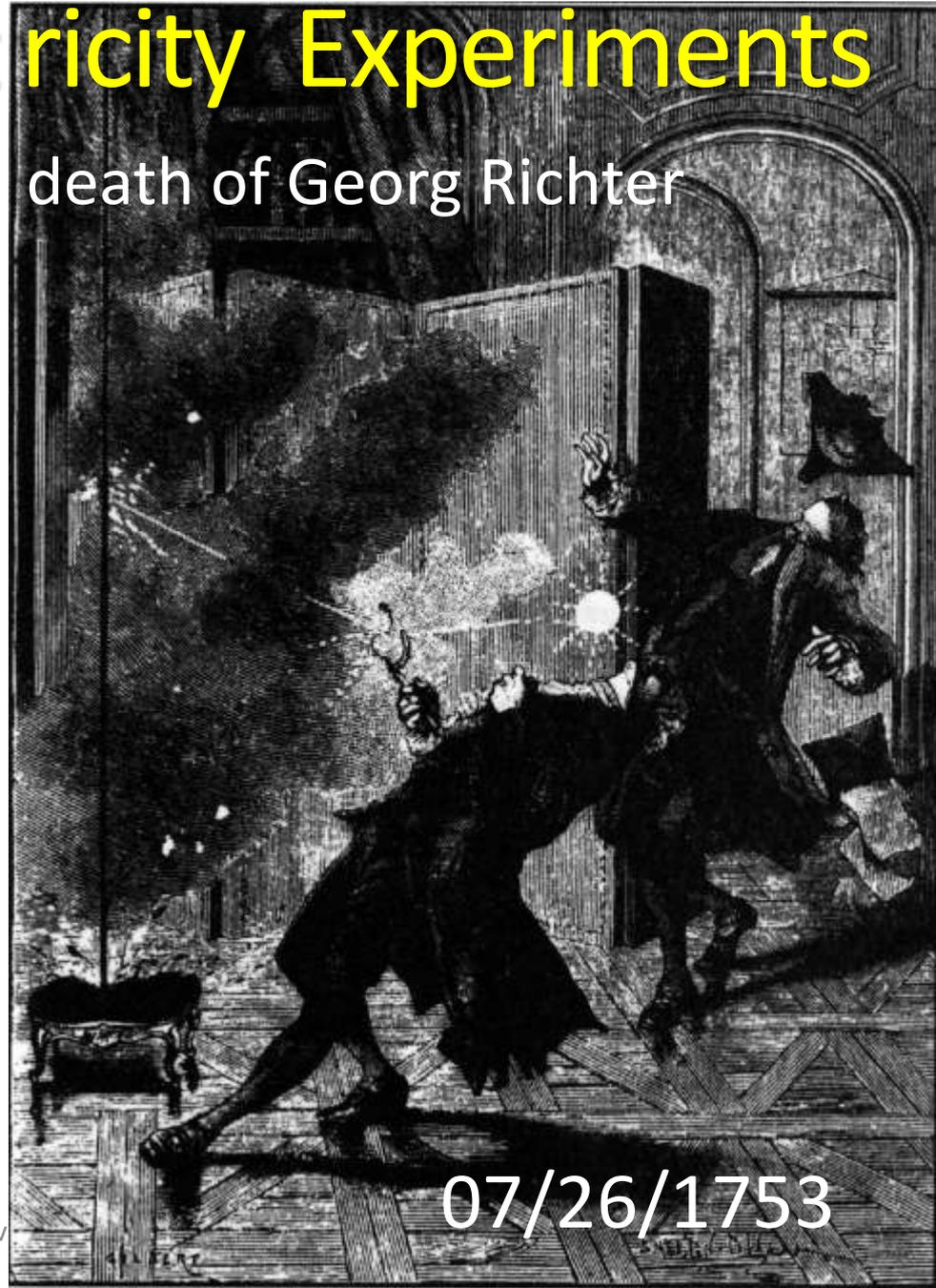
- Electricity studies 1745-1760's
 - first quantitative measurement of electricity
 - Two measuring instruments (scales and electrometer) - with G. Richman
 - Automatic “lightning-meter” proposal
 - helicopter for atmospheric research
- The theory of air electricity
 - The friction in the vertical air currents
 - Applied to Northern Lights/ auroras
- Color theory in electric discharge

Lomonosov's Electricity Experiments



Richman electrometer

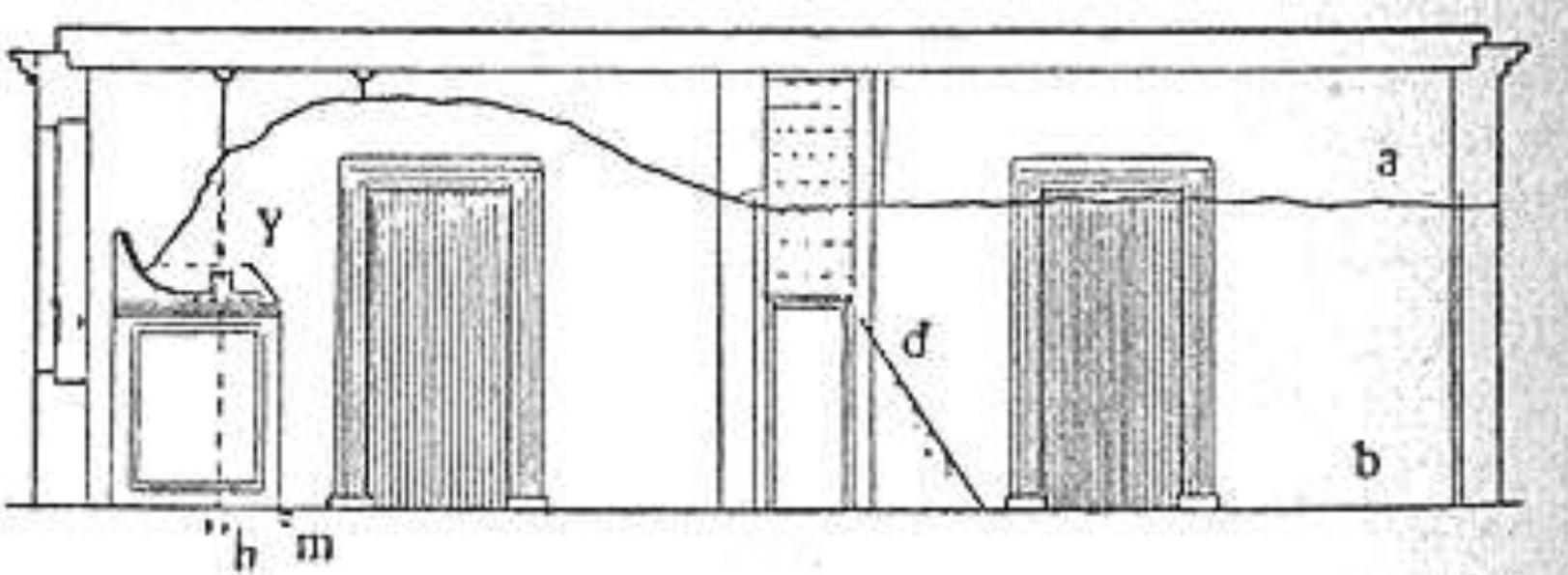
nosov



death of Georg Richter

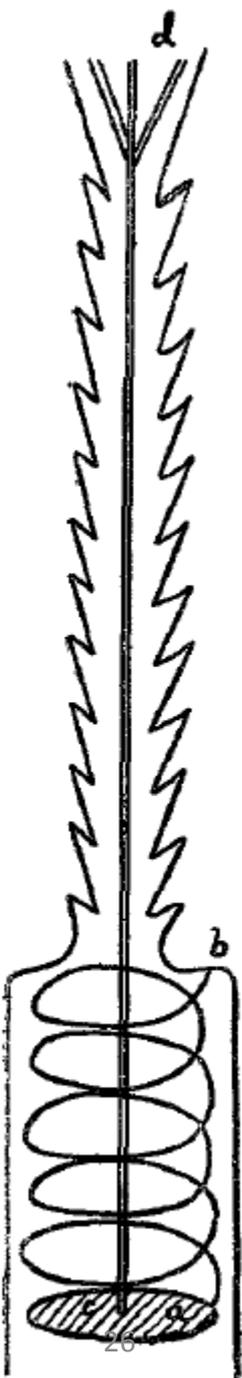
07/26/1753

Georg Richman and Lomonosov



«Грозовая машина» в доме Г. В. Рихмана в 1753 г. (h — место, где стоял Рихман в момент удара молнии).

Lomonosov response – device for automatic detection of max charge →



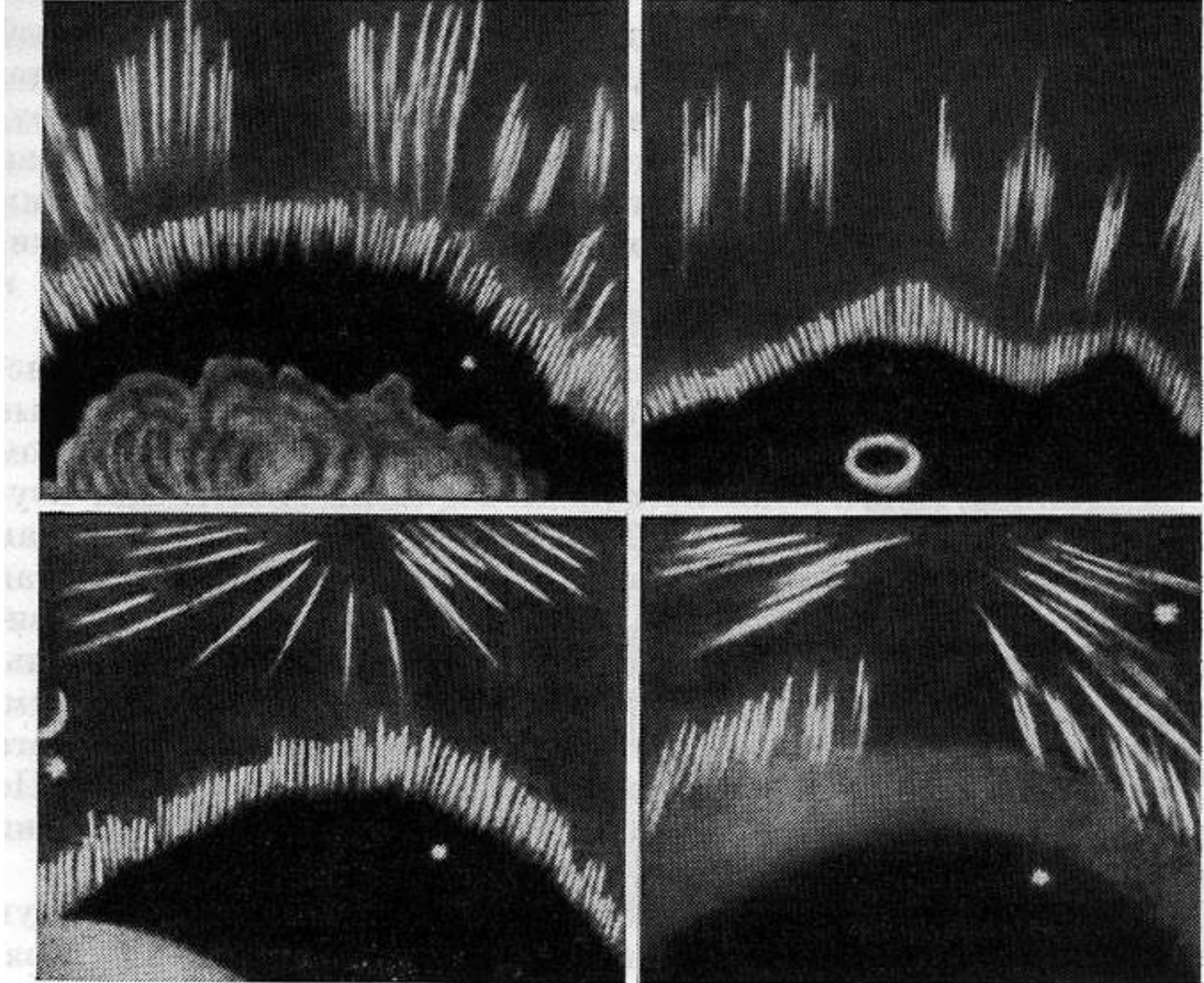
Theory of Atmospheric Electricity

Air density increase due to lower temperature in upper atmosphere is ~2.5 times stronger than density decrease due to high elevation

1753



Explanation of Northern Lights

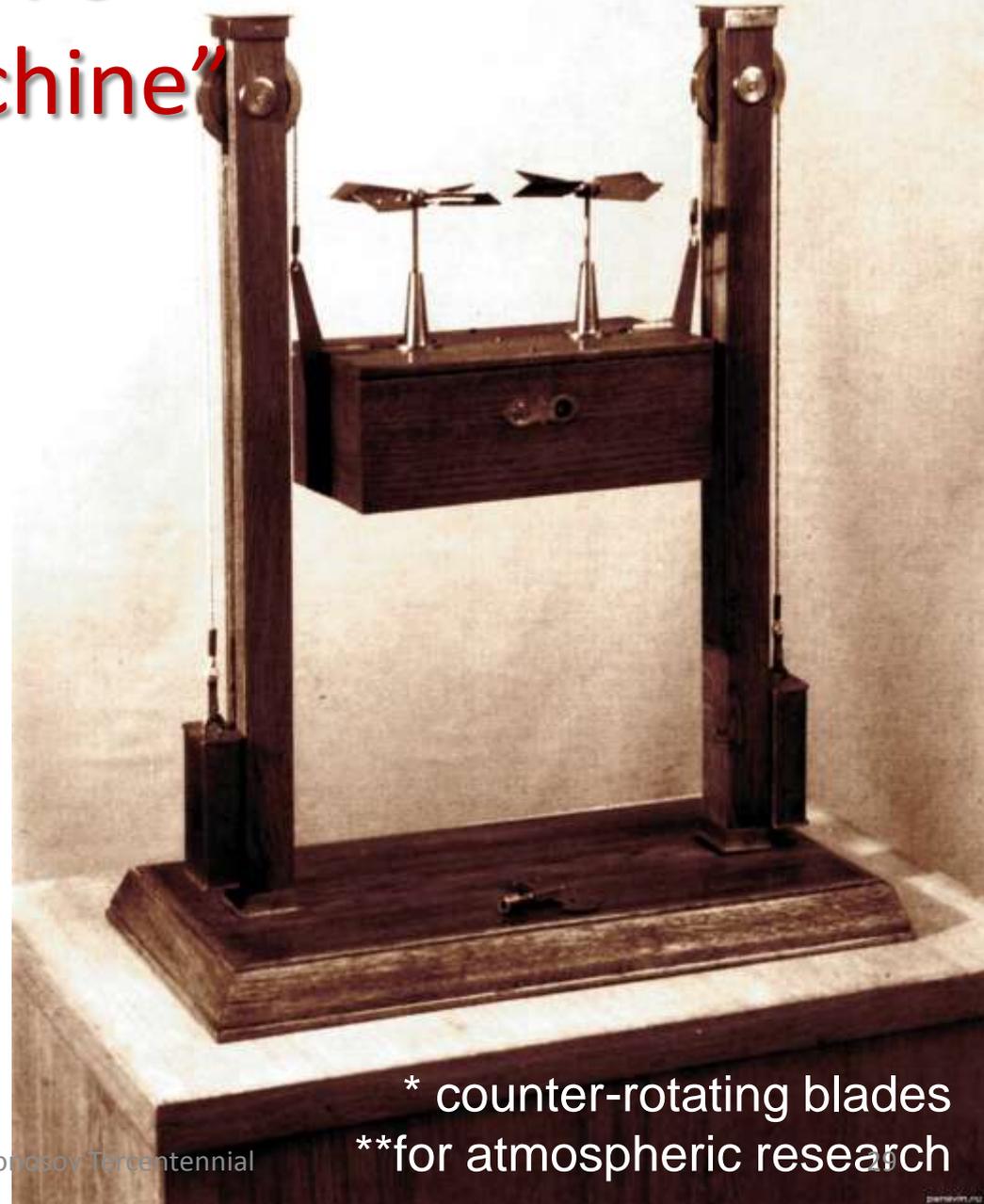
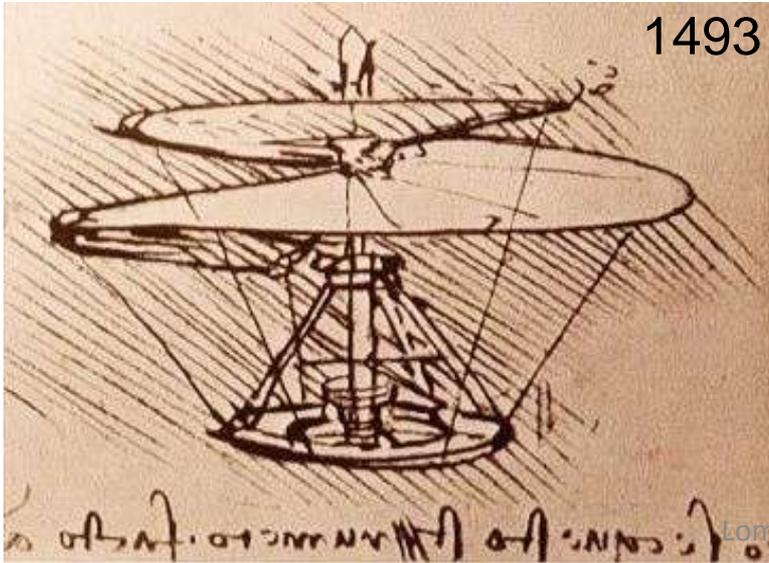


1754 Lomonosov's "Aerodynamic Machine"



Chinese top
4th cent. A.D.

Leonardo's "airscrew"
1493



* counter-rotating blades
**for atmospheric research

Chinook CH-47D

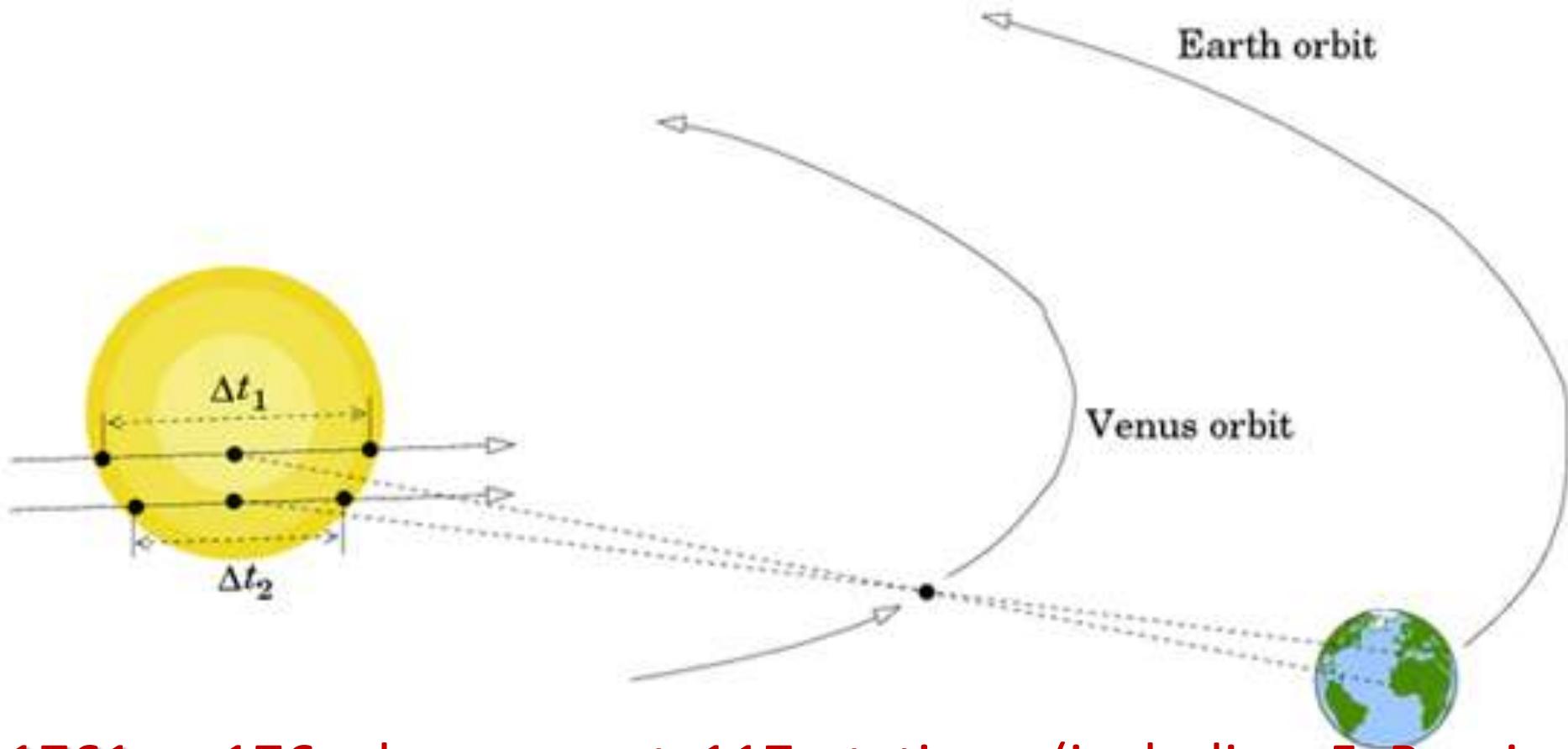


also in *Yak-24*, *Piasecki H-21*, all *Kamov's* helicopters

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

Transit of Venus June 1761



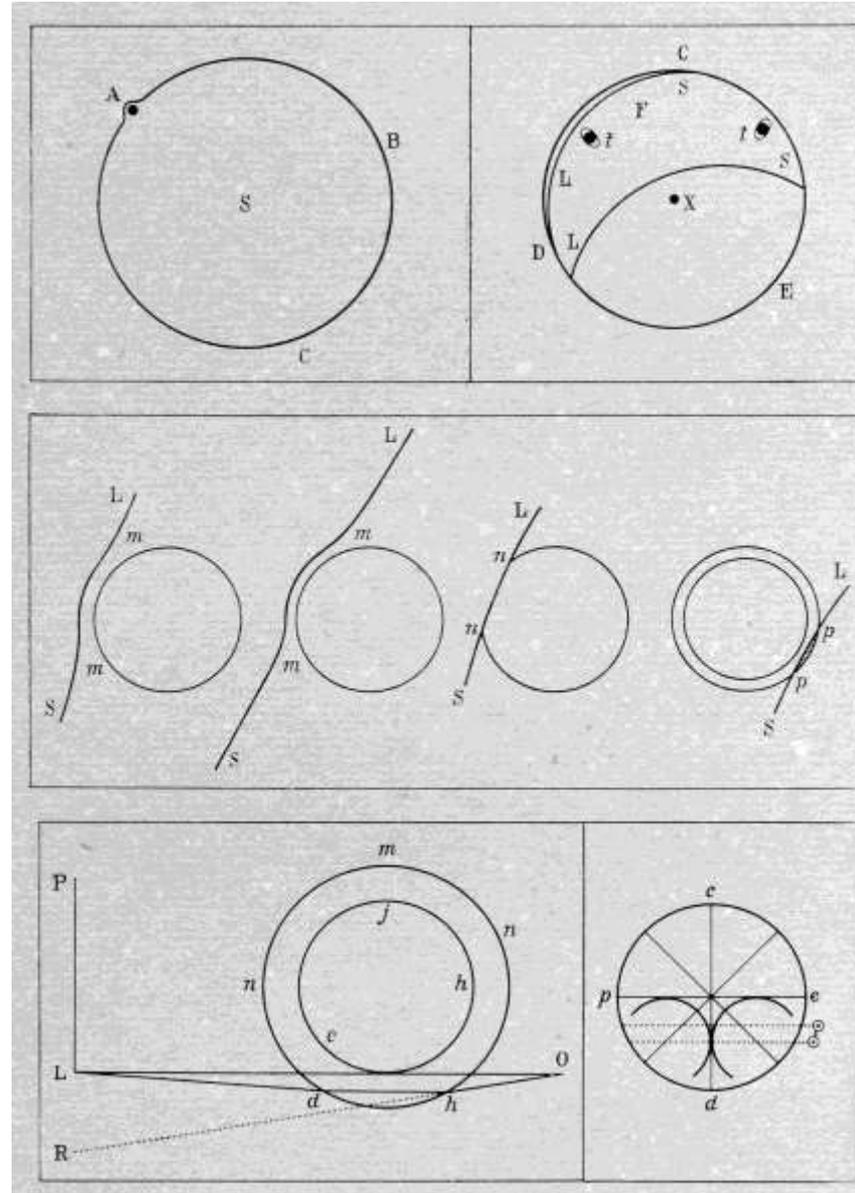
1761 – 176 observers at 117 stations (including 5 Russian astronomers in 3 cities all over Russia); major goal – determine distance to the Sun; very rare event – ToV in 1769, 1876, 1884 and 2004 ...

Lomonosov's Actions in 1761



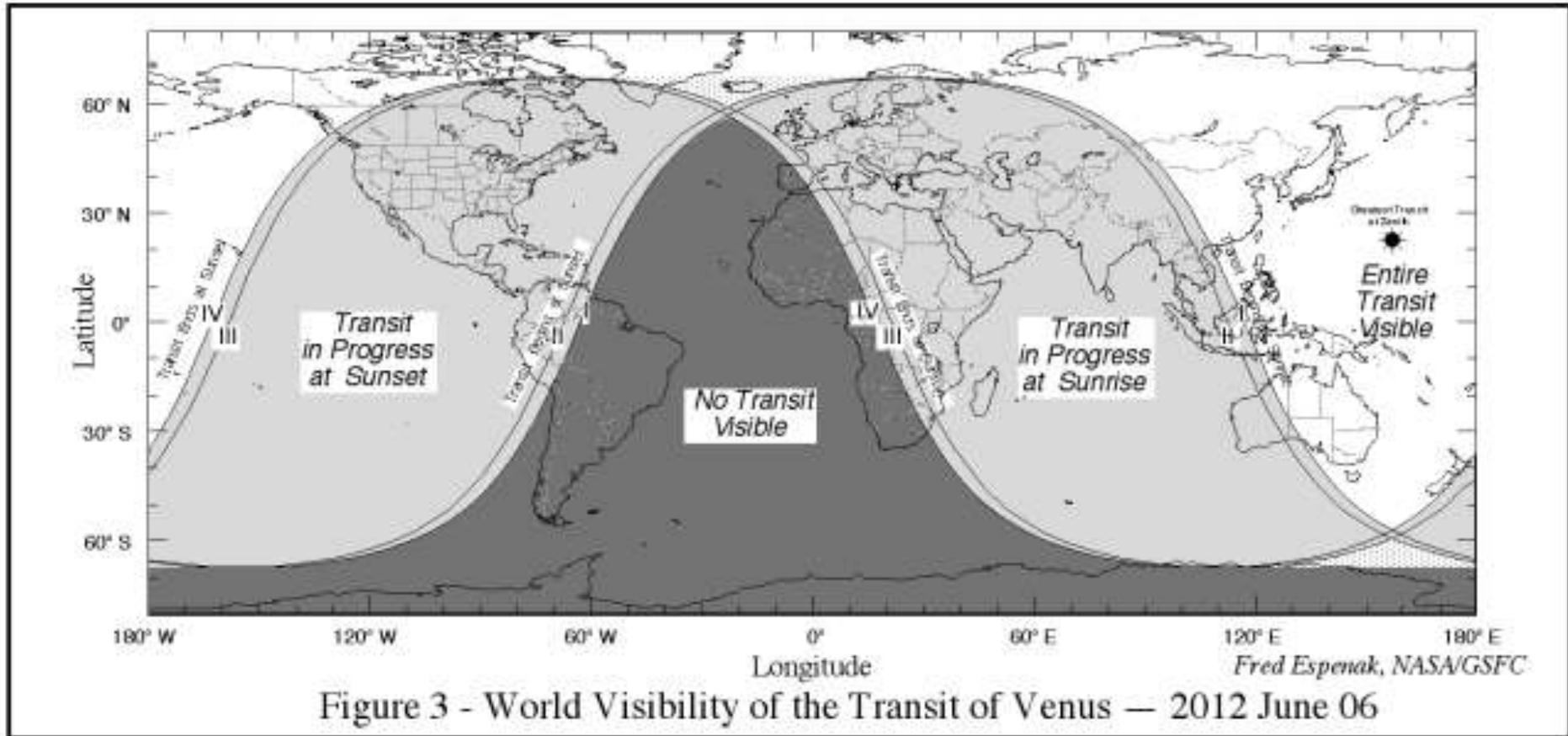
Important! – he used lightly smoked glass rcenter

Lomonosov Discovery of Atmosphere of Venus



Transit of Venus June 5-6, 2012

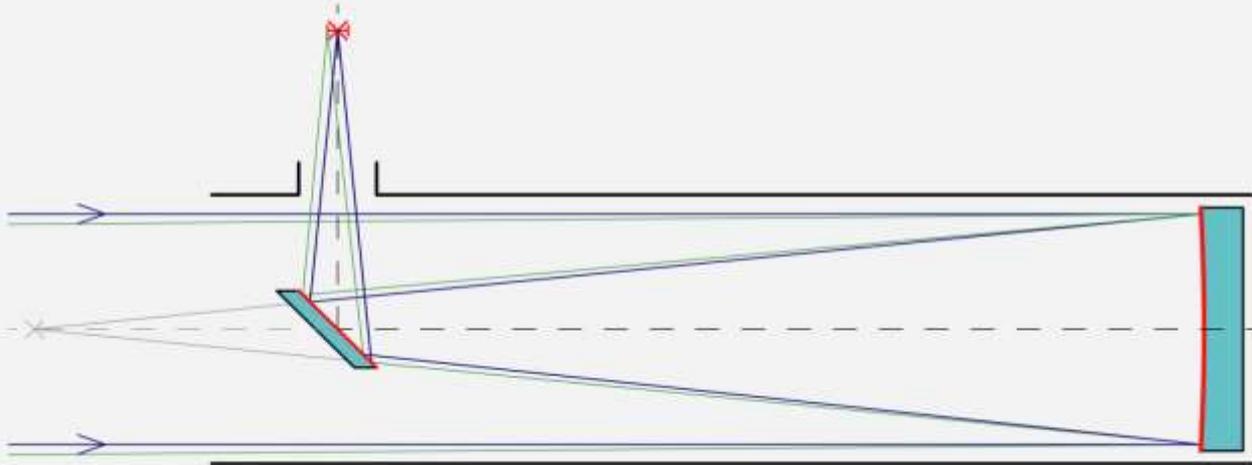
You can see it, your kids can see it, your neighbor kids can see it!



250th Anniversary of the Discovery of Venus Atmosphere by Lomonosov

Newton-Teleskop

I. Newton 1668

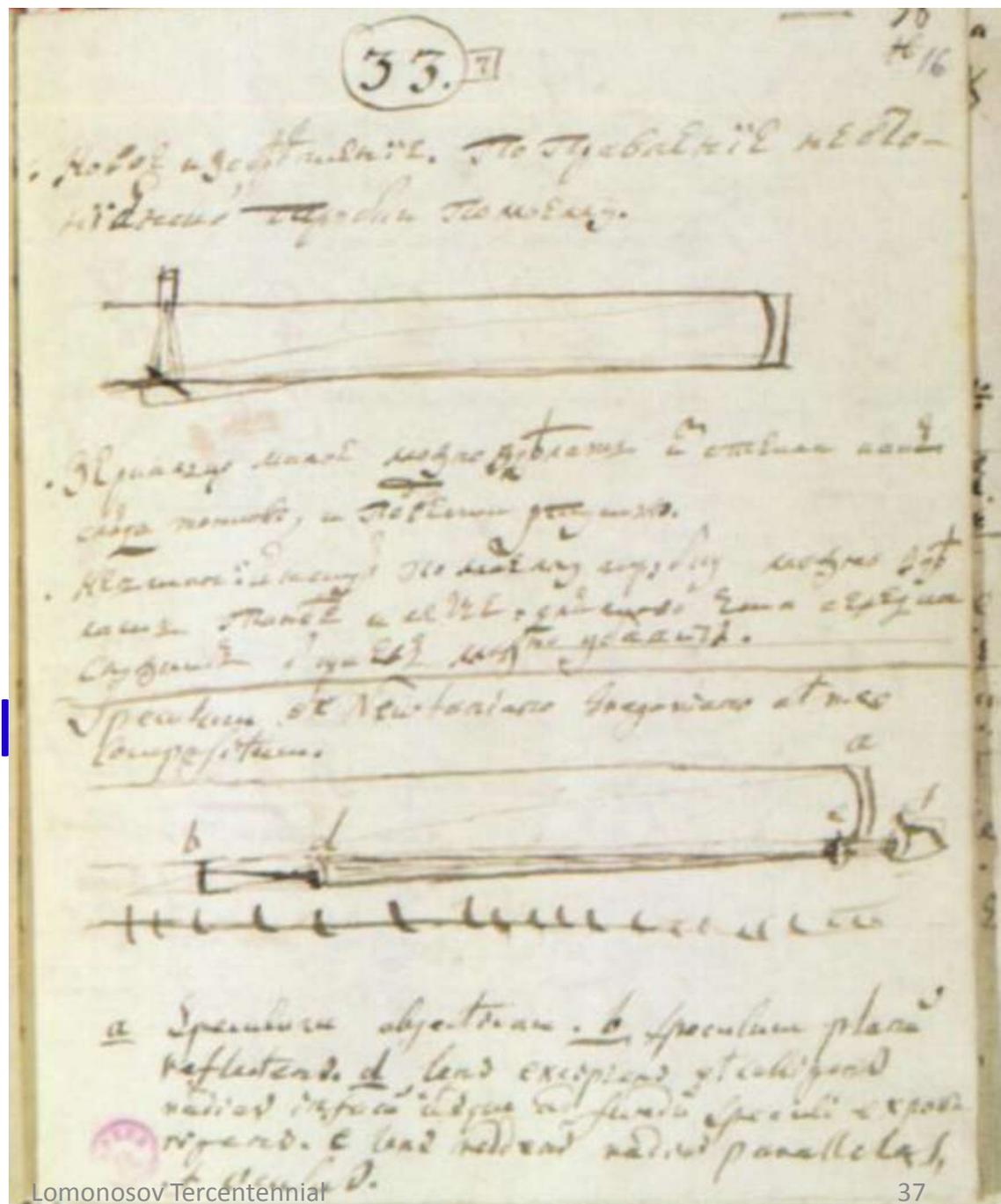


M. Lomonosov 1756

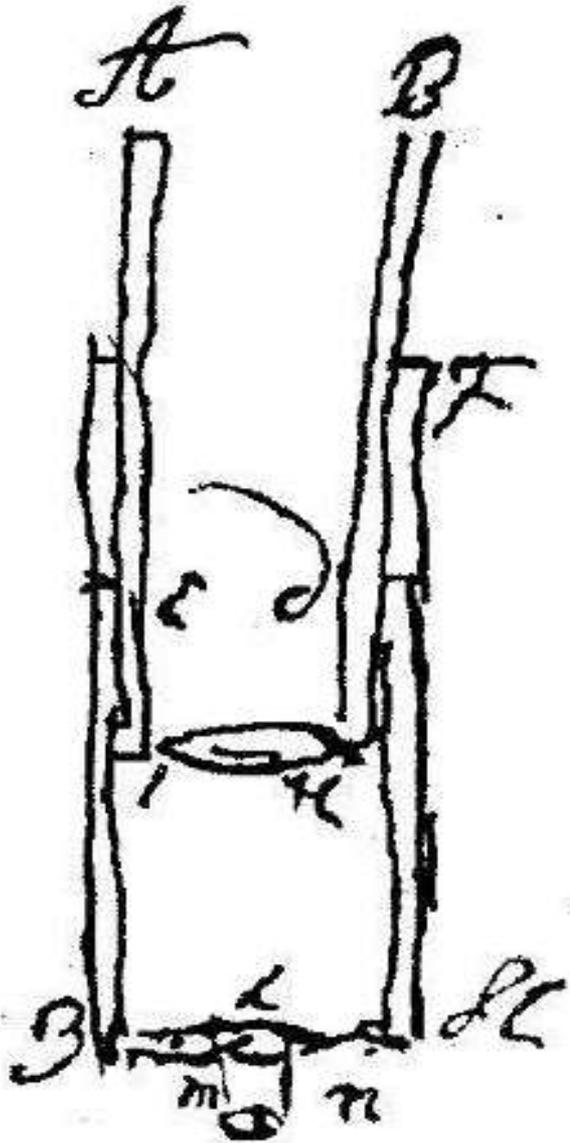


Lomonosov Reflector Telescope

- Lomonosov's
concept 1756
successful model
1762
- William Herschel
1789



Night-Vision Tube 1756



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

“Siderostat”

flat mirror

W.Herschel
1789

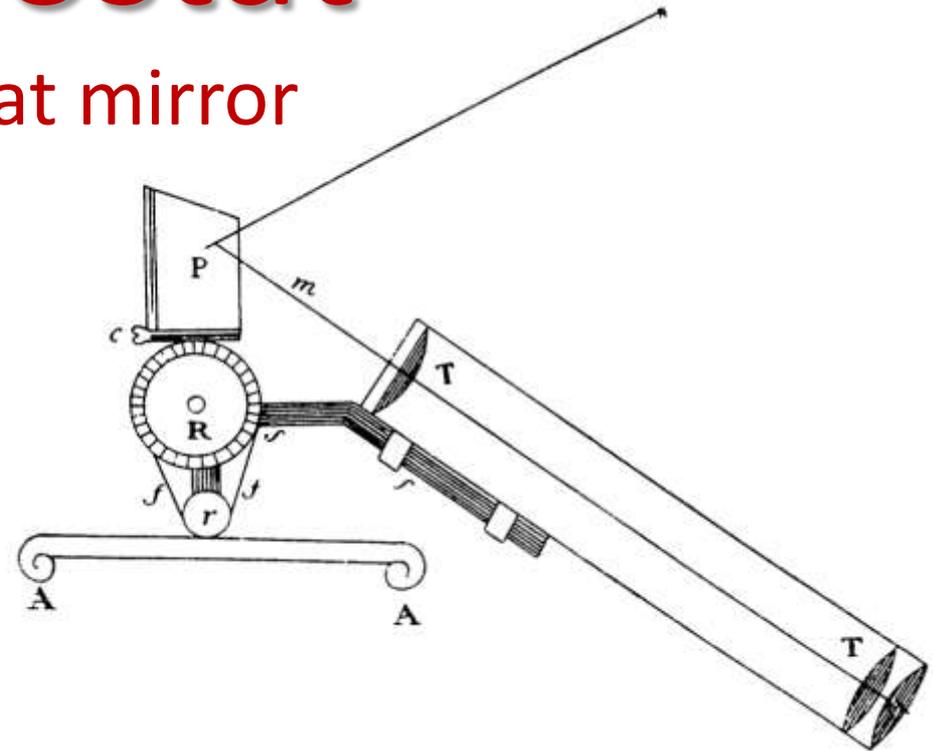
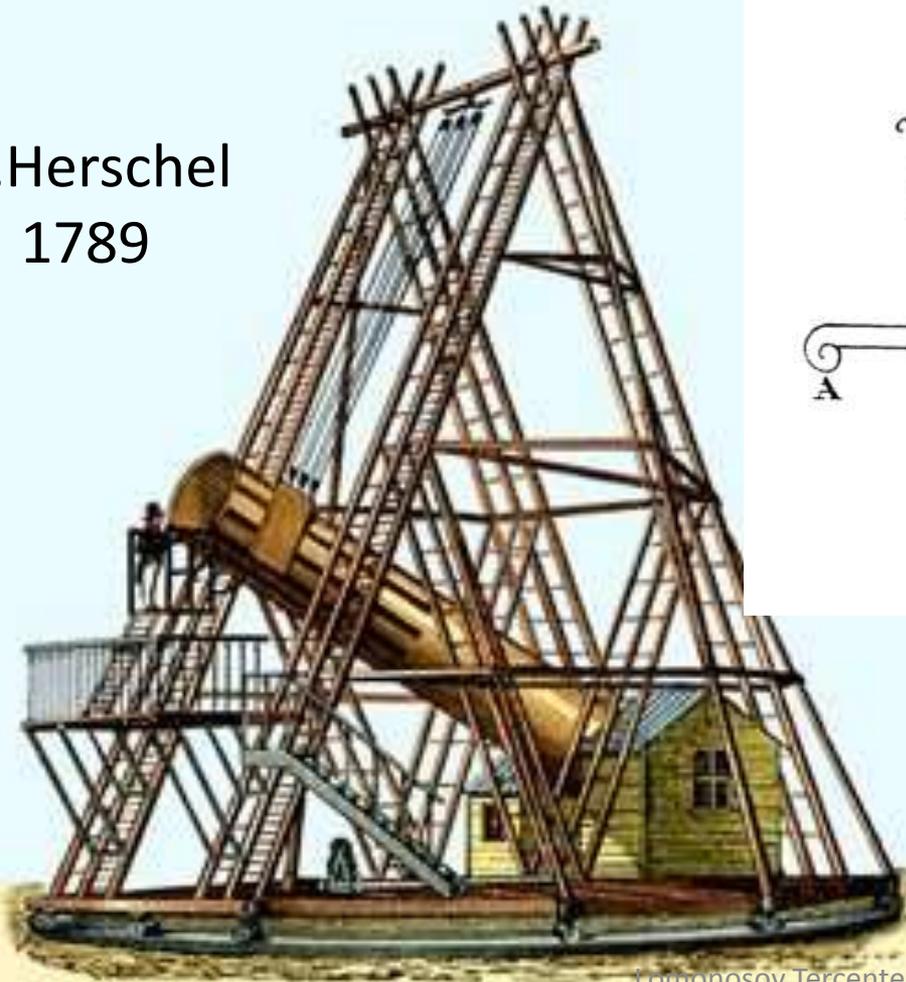


Fig. XII.

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

POLL #1

- How many **non-Russian** speakers are in the audience? (raise your hand, please)
- How many of you **HAVE** heard of Lomonosov?
- How many **Russian-speakers** are in the audience?
- How many of you have **NOT** heard of Lomonosov?

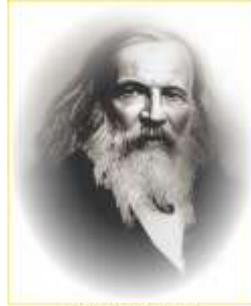
History of Science in Russia



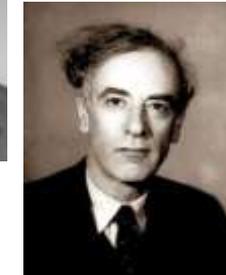
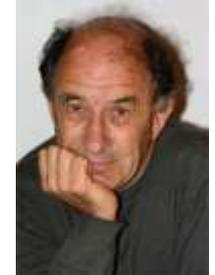
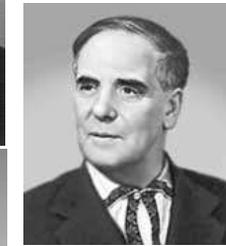
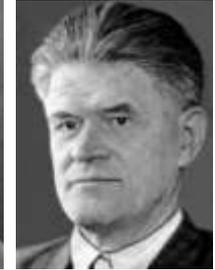
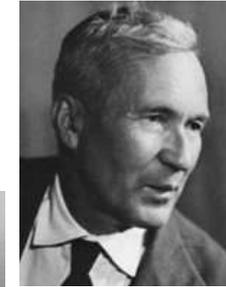
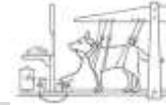
$$e^{i\pi} + 1 = 0$$



$$\frac{\rho v^2}{2} + p = \text{const}$$



Дмитрий Иванович
МЕНДЕЛЕЕВ



1700

1750

1800

Lomonosov Tercentennial

1850

1900

1950

2000

Batavia, Lomonosov and Franklin



Self-Made Man by Bobby Carlyle

Lomonosov and Ben Franklin

Similar legacies
in Russia and US:
Key figures of
Enlightenment &
1st orig. scientists



Britannica 1954

¼ page

5 pages

БСЭ (Sov.Encicl.1978)

6 pages

2 pages

Wiki Eng

4 pages

20 pages

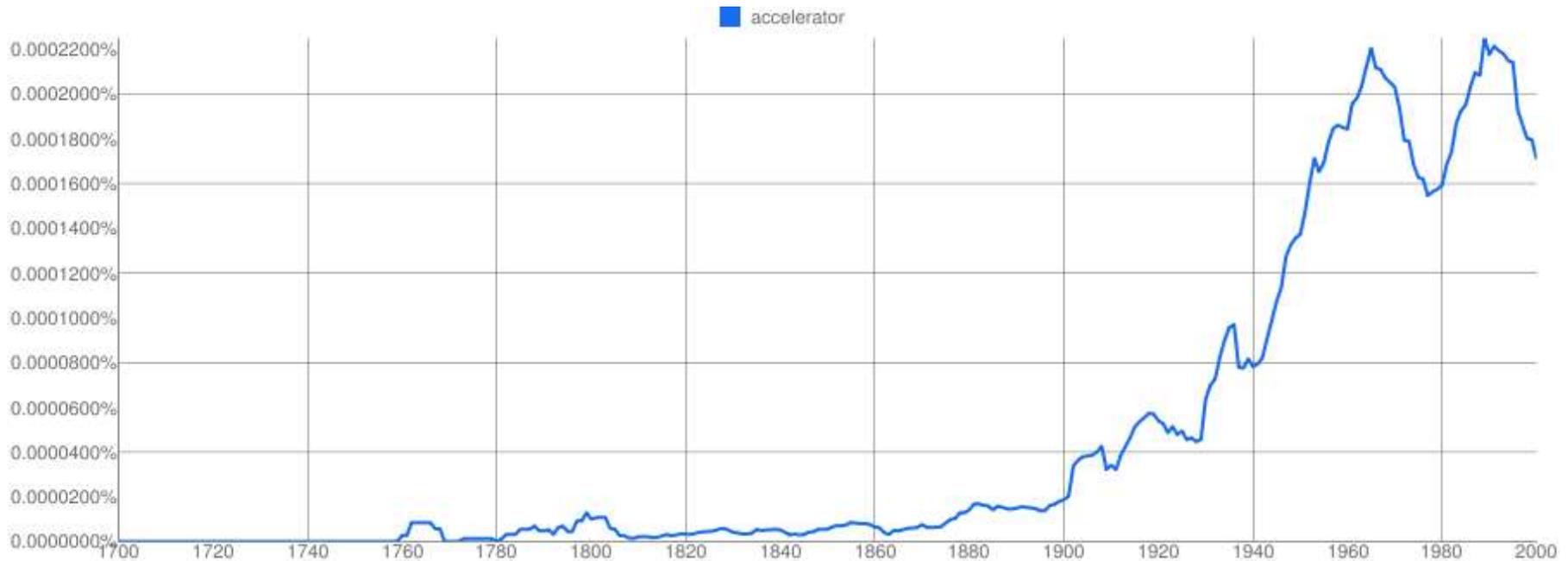
Wiki Rus

35 pages

5 pages

Google books Ngram Viewer

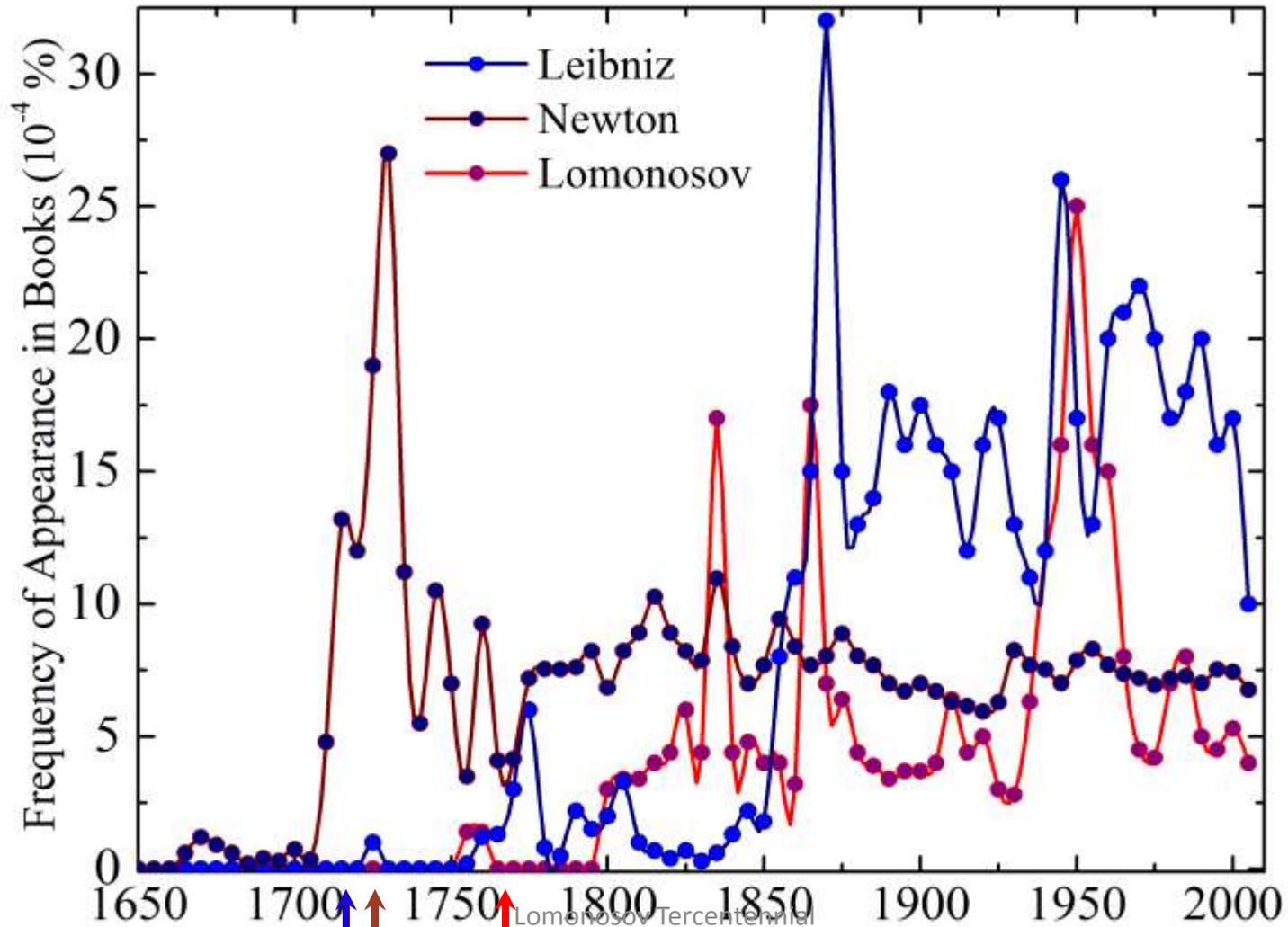
- New culturomonomics tool:
 - <http://books.google.com/ngrams>



- Frequency of appearance of the word or combination of words in the published books vs year
- >5M digitized books (5%), 500B words, 7 languages

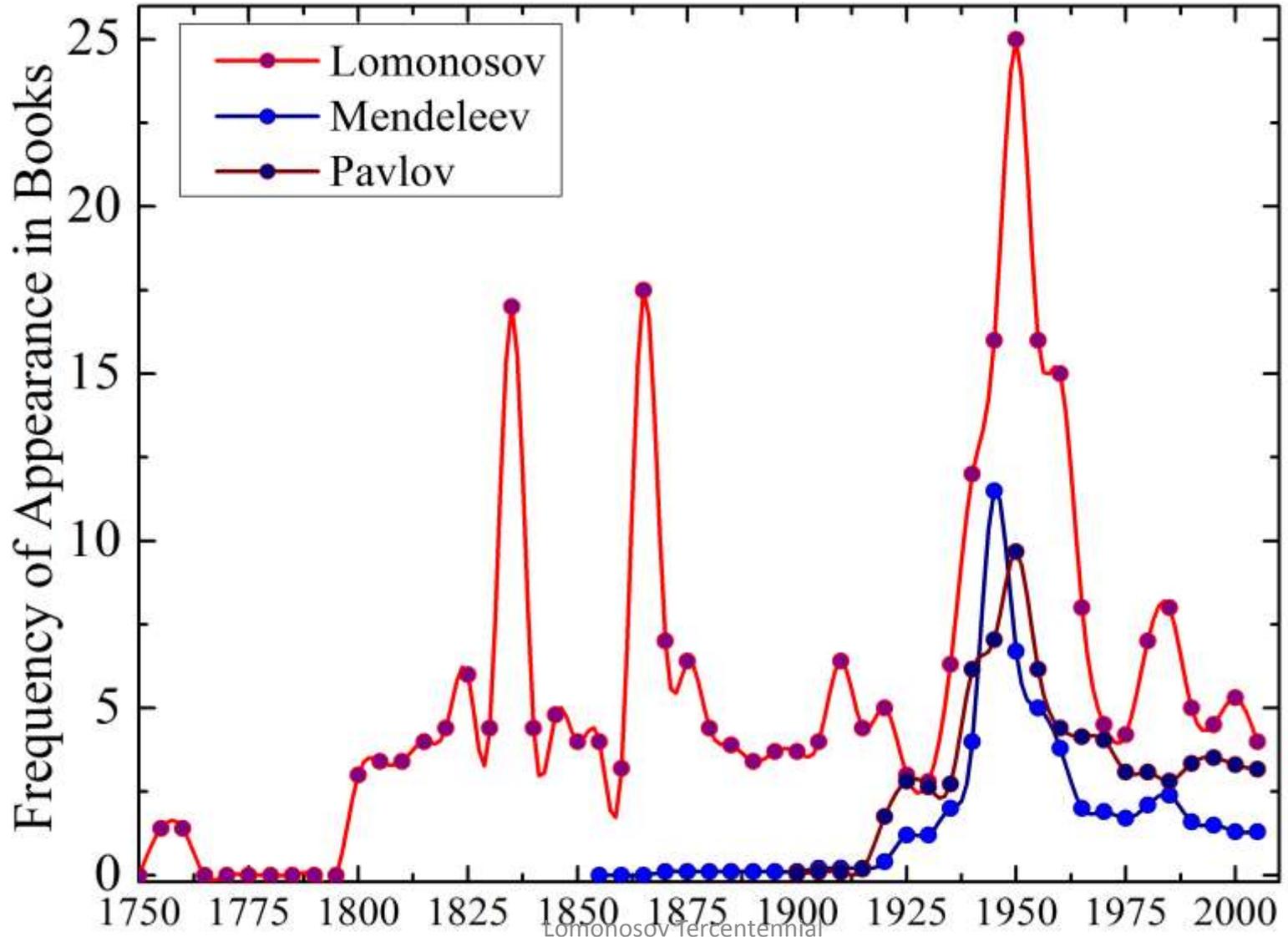
Three Scientific Geniuses:

English, German, Russian book collections



Most Prominent Russian Scientists

Russian book collection



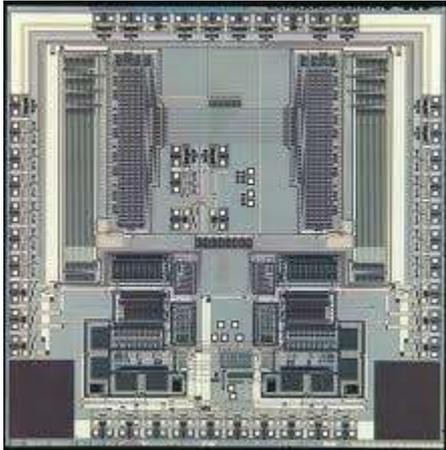
Lomonosov's Tercentennial 2011

- Lomonosov's 2011 celebration is state-wide in Russia - preparations started in 2006 per Russian President's order
- The plan of celebration lists 36 actions for Russian Ministries of Foreign Affairs, Education and Science, Postal Office, Russian Academy of Sciences, Arkhangelsk Governor and includes:
 - All-Russian "scientific competition" of young scientists
 - "Lomonosov classes" in every Russian school
 - Postal stamps, medals, UN and UNESCO events
 - Russian Chemistry Olympiad in Arkhangelsk
 - "Lomonosovskie Chteniya" (Lomonosov's Seminars) in Russia and abroad
 - Number of Russian and Int'l conferences on subjects of chemistry, physics, fleet, geography, etc
 - Books on Lomonosov including new popular biography
 - Movie on his life
 - New edition of Lomonosov's works
 - Expositions in Russia and abroad
- City of Arkhangelsk (birthplace of Lomonosov) has their own list of celebration events and actions (some 100 items long).

On the Nature of Scientific Genius

- I will need to guide you through a concept of complexity of sciences and a little bit of math

An Example of Complex System



“Moore’s Law”

number of transistors on one chip
doubles every ~2 years



Theorem of Complex Systems

The system is complex → many problems and parameters →
one can not solve all the problems at once →

address them step by step

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

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

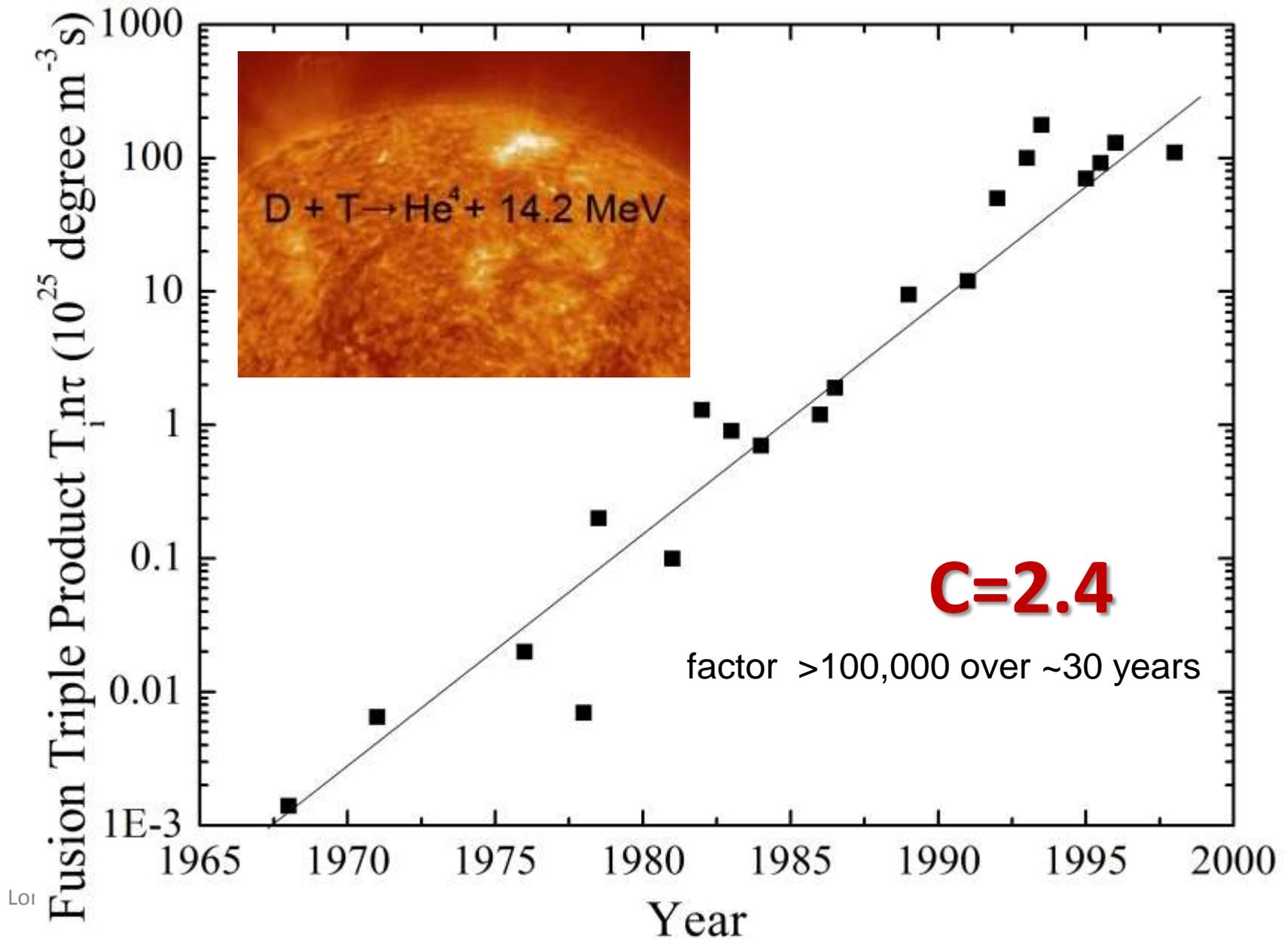
...or in time →

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

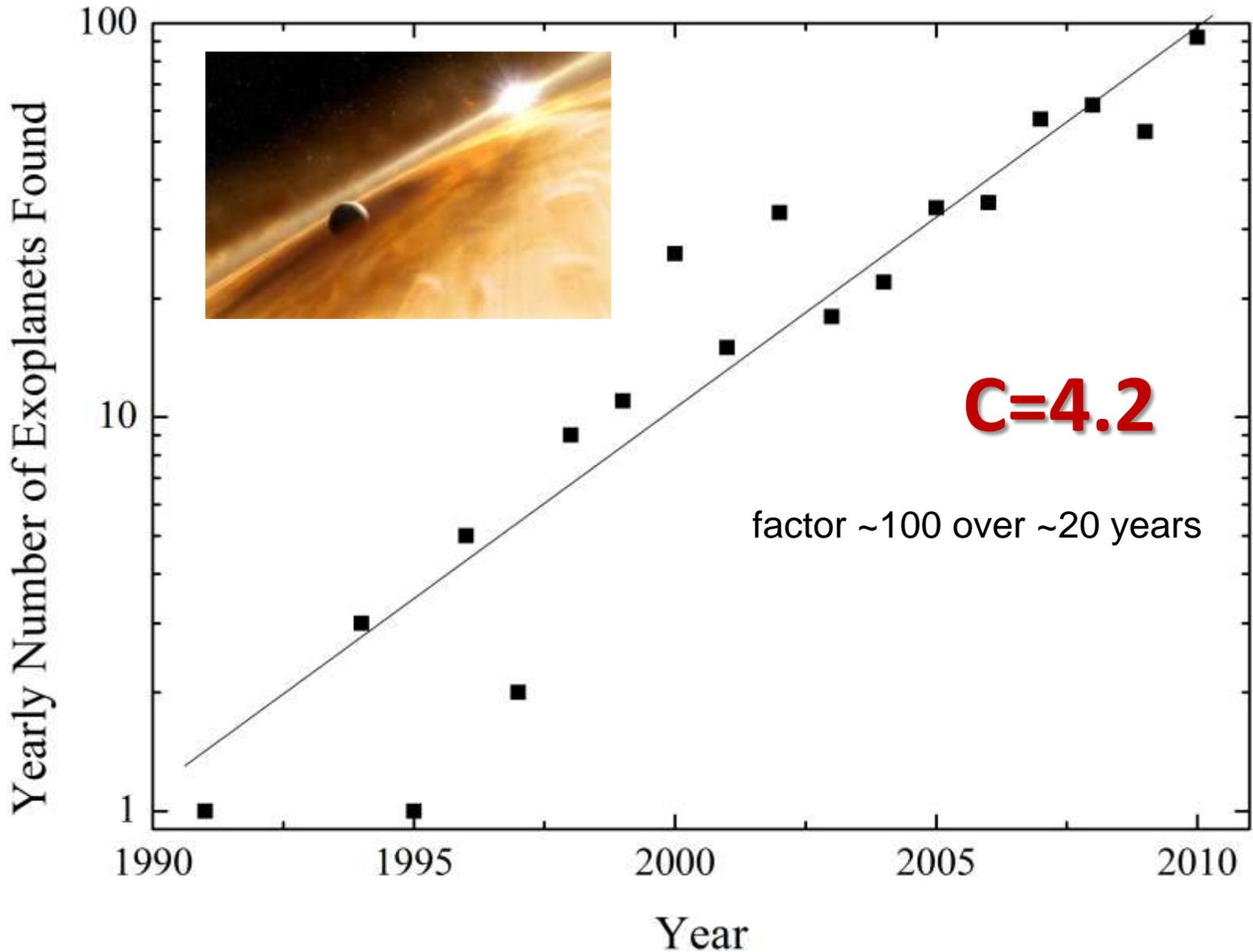
C (Complexity) = # years to e-fold progress

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

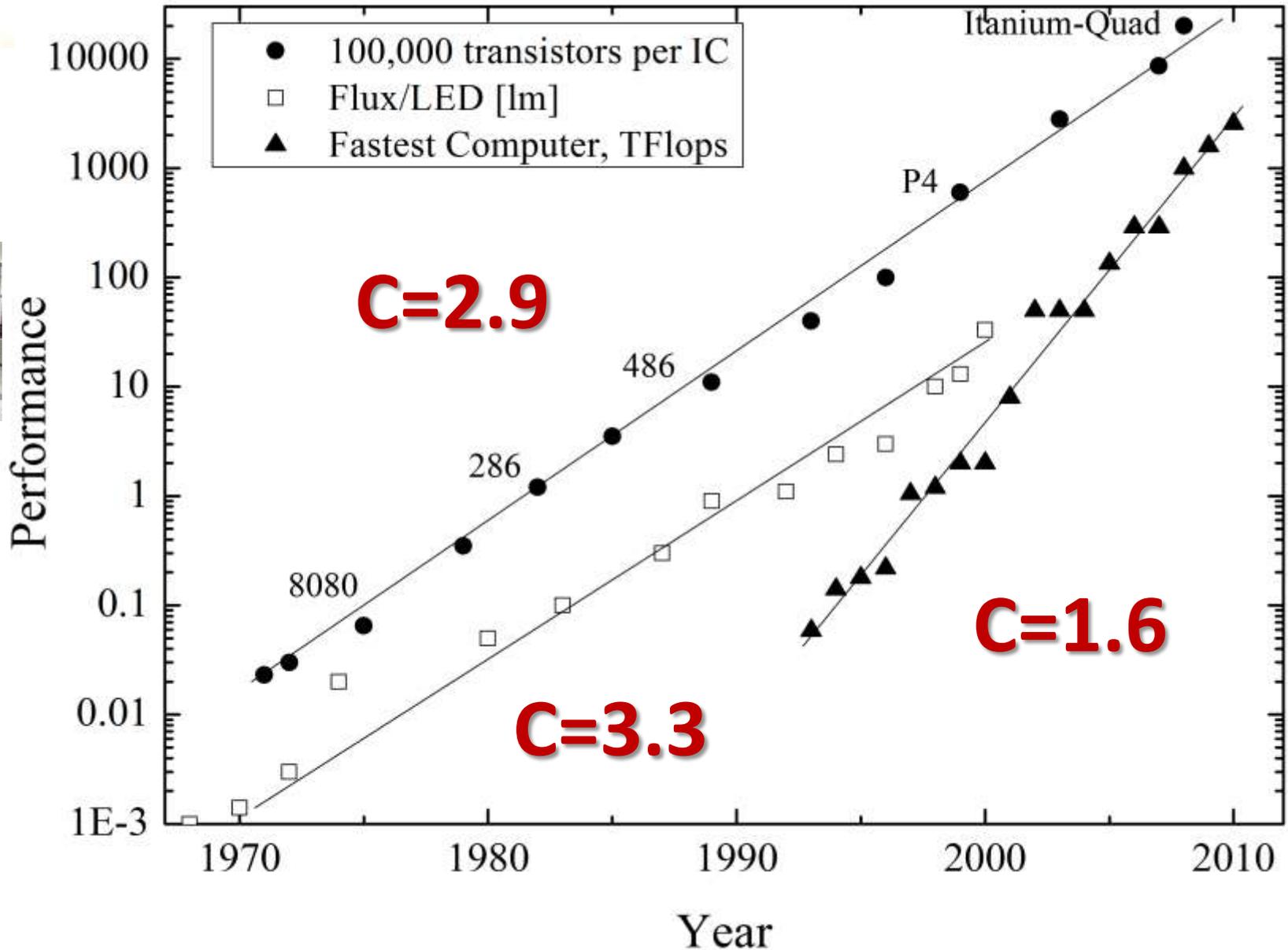
Thermonuclear Reactors



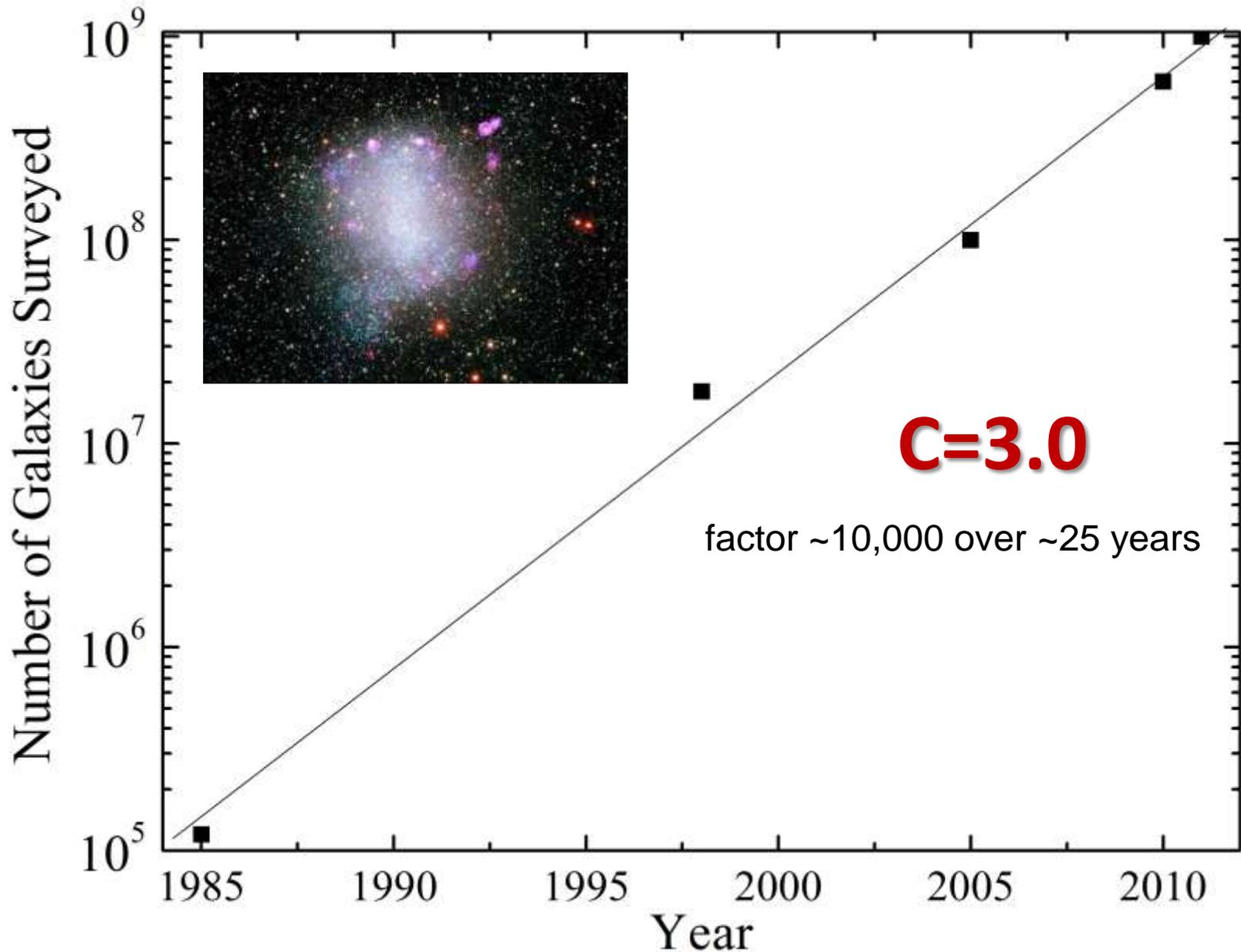
Exoplanets



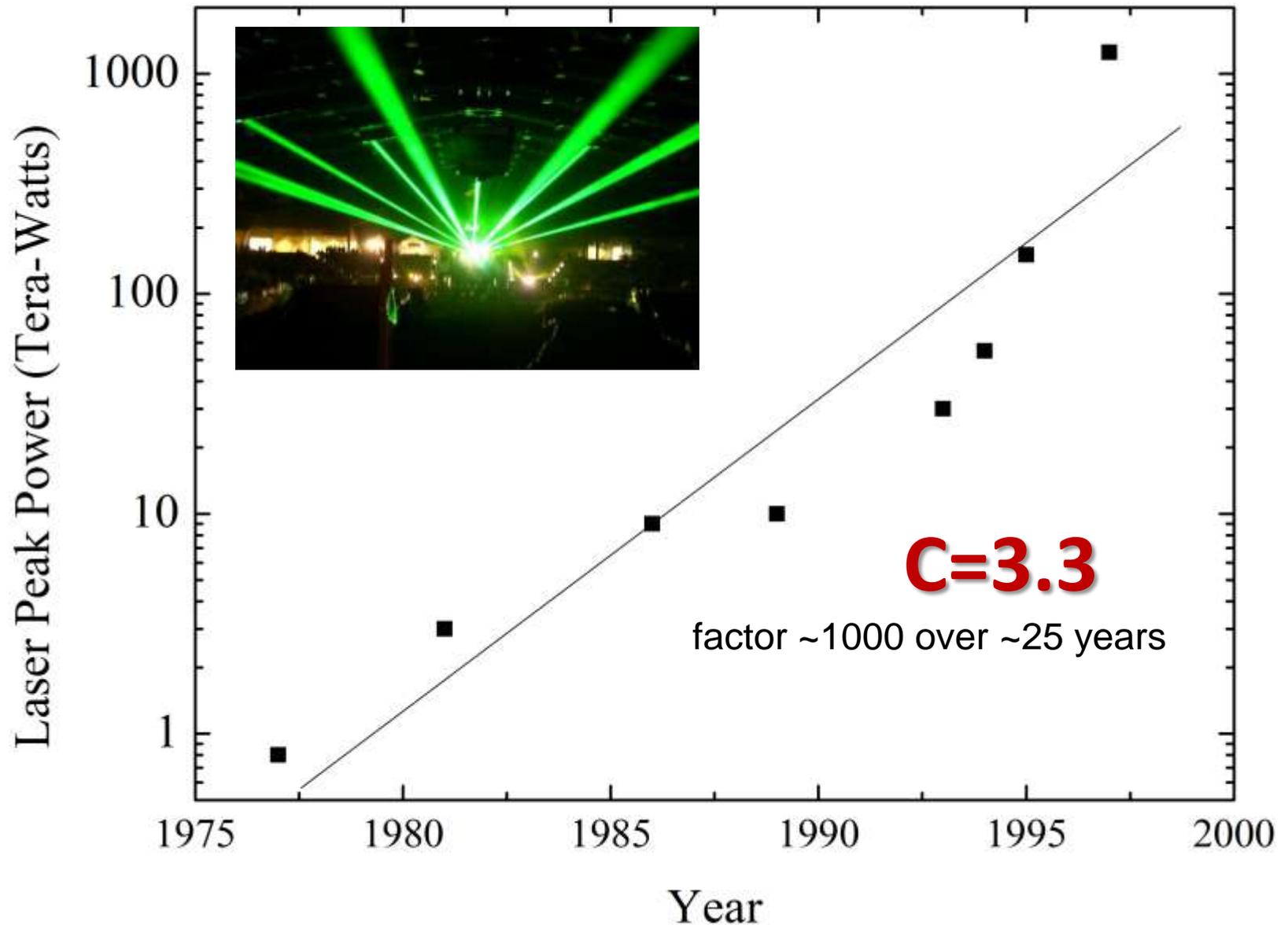
Moore's Law, LEDs, SuperComputers



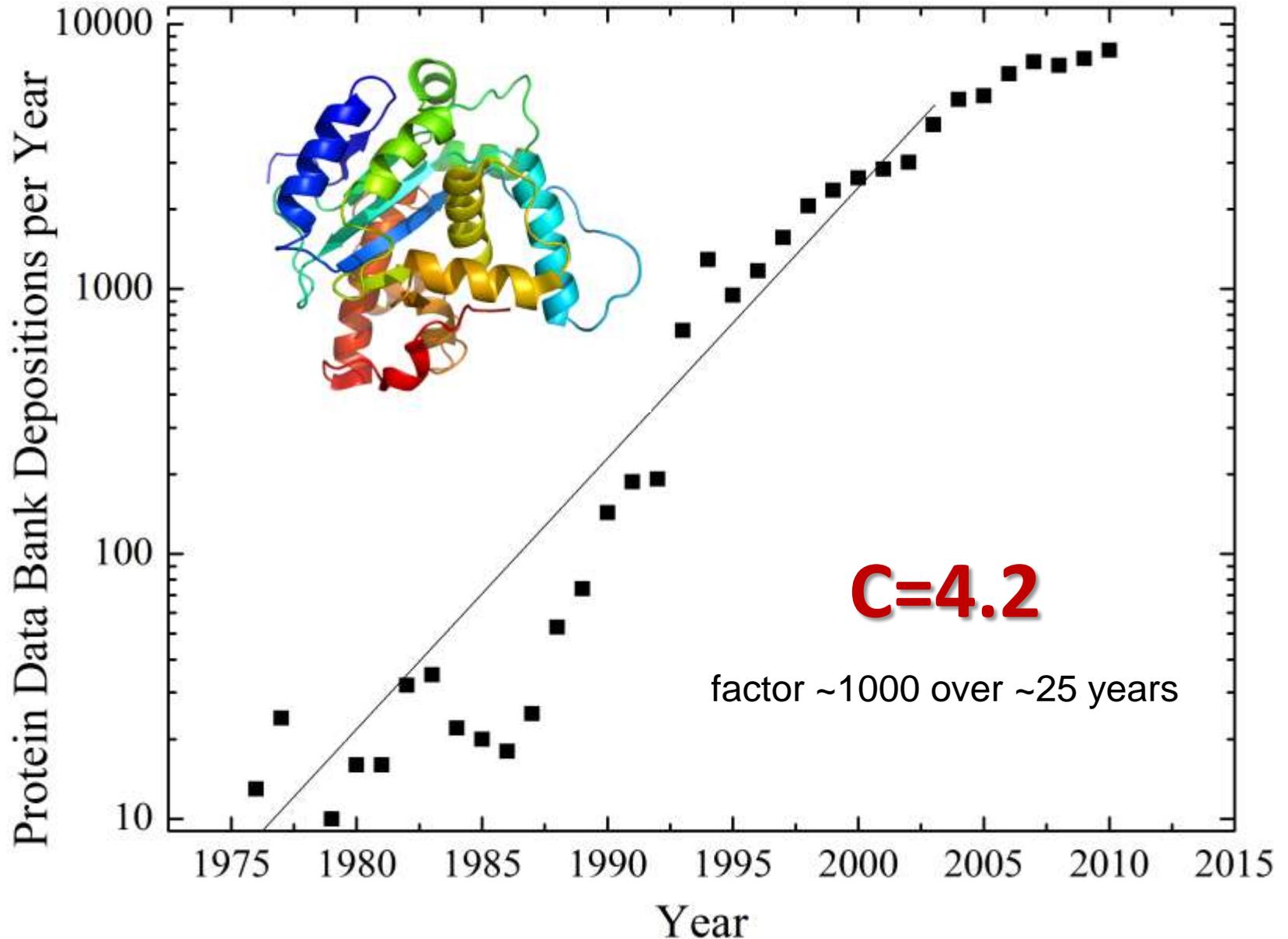
Number of Observed Galaxies



Ultra-High Power Lasers



Protein Structures deposited in PDB



“Complexities” of Sciences

C

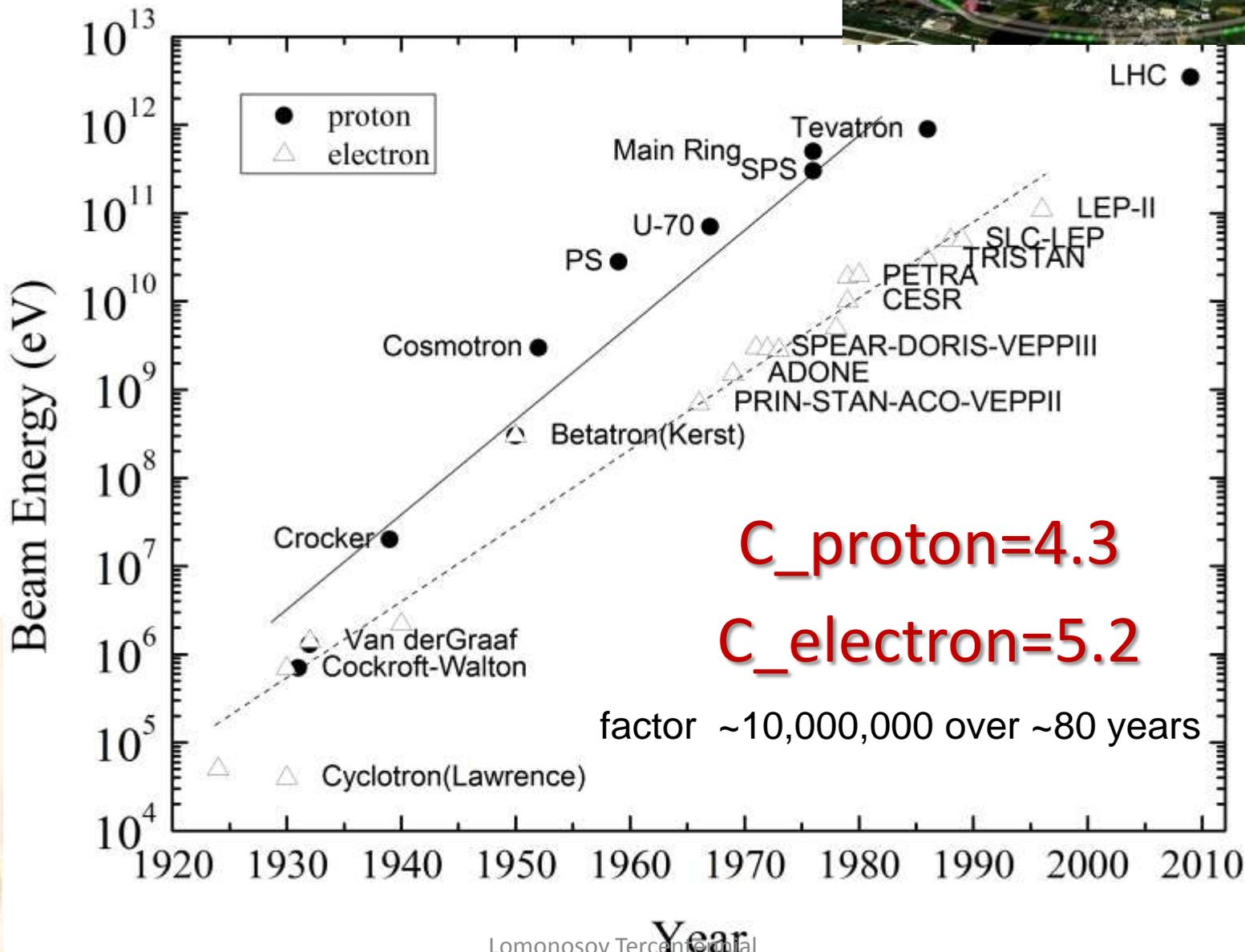
Supercomputers	1.6	“easier”
Fusion Reactors	2.4	
Moore’s law	2.9	
Galaxies Surveyed	3.0	
LED light	3.3	
Laser power	3.3	
Protein structures	4.2	
Exoplanets search	4.2	“harder” ₅₈

POLL #2

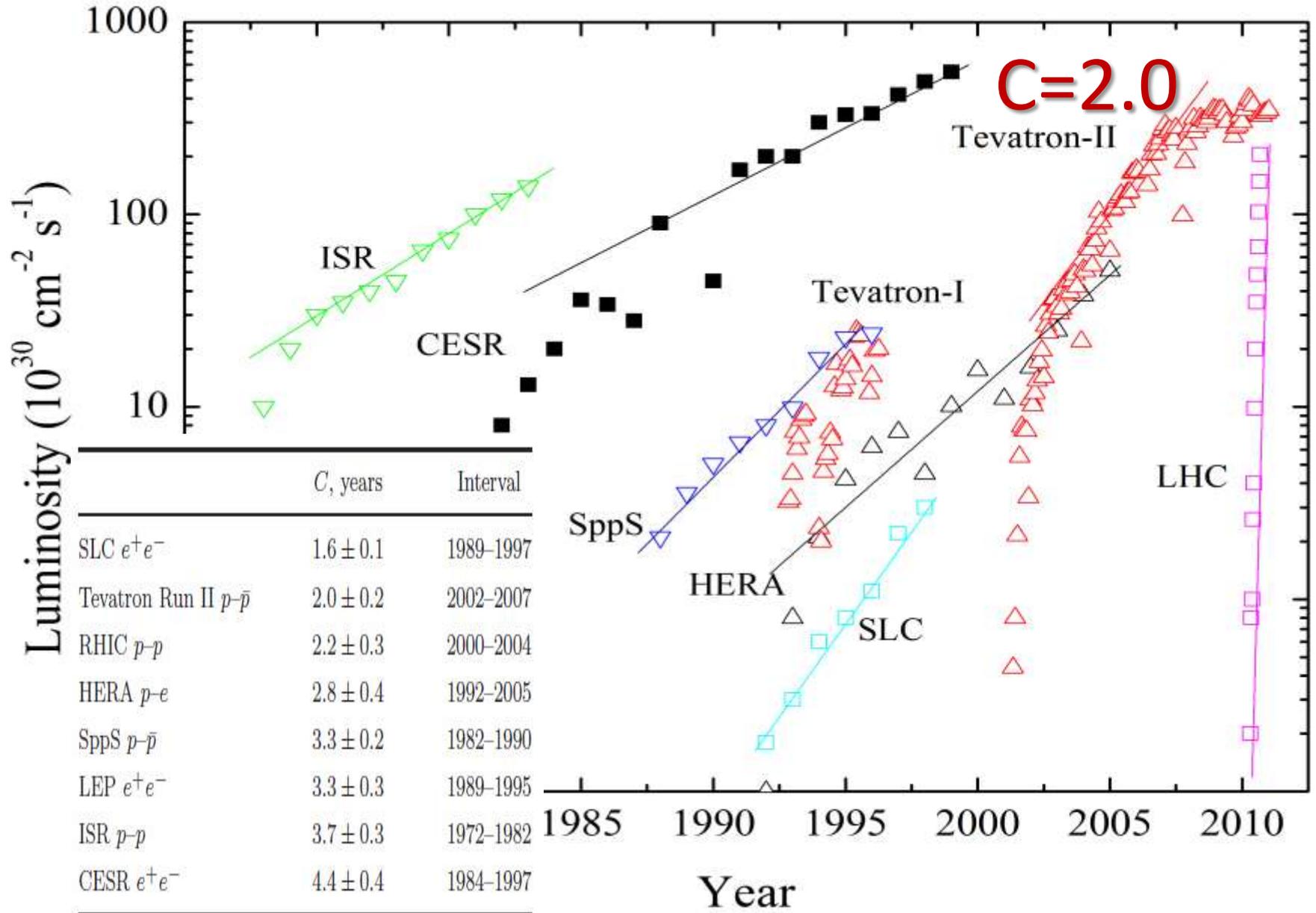
- How many of you think that accelerators are **harder (more complex)** than “Moore’s Law”?
- How many of you think that accelerators are **easier (less complex)** than “Moore’s Law”?



Beam Energy



Record Luminosity of Colliders



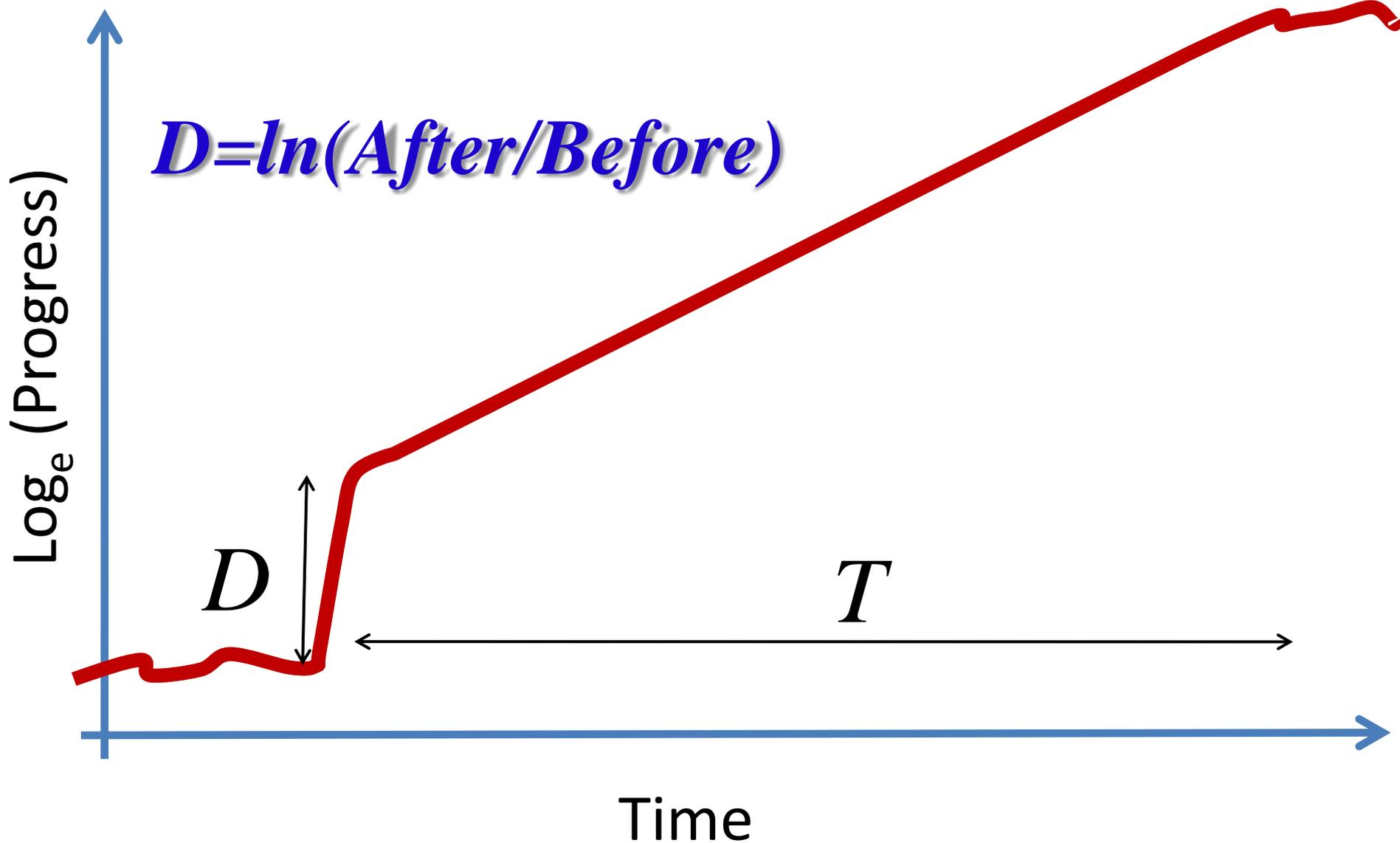
Back to Moore's Law – Who Started it?



1947 Bardeen, Brattain

Lomonosov Tercentennial

“Genius Effect”



To be able to compare historical figures, more useful is:

“Genius Formula”

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

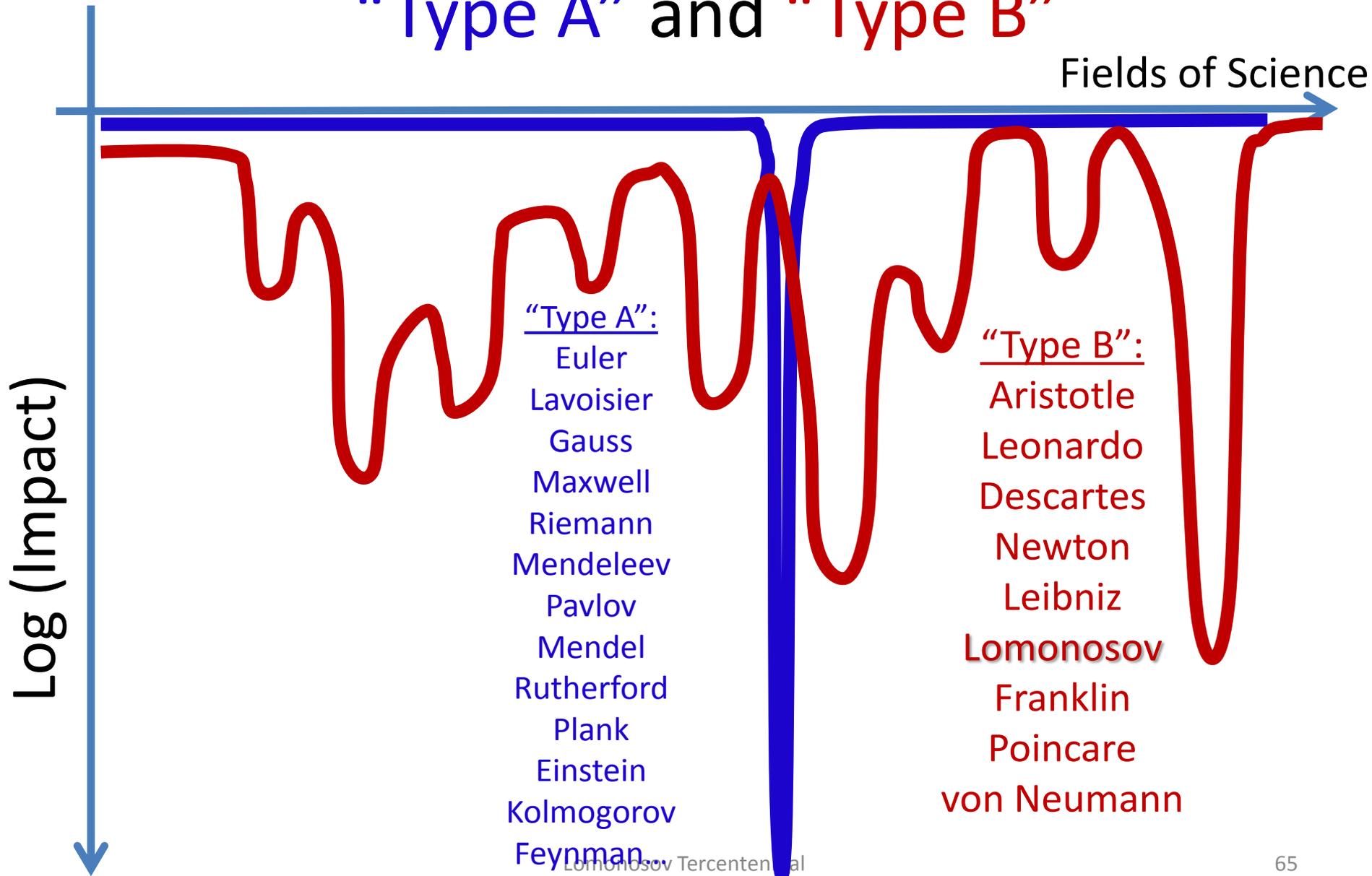
ln(Time)
duration of impact

Breadth
of areas

Depth
of impact
=*ln*(After/Before)

“B-factor” Scientific Geniuses:

“Type A” and “Type B”



Lomonosov's G :

- Grammar $\ln(100 \text{ yrs}) \times \ln(2) = 3$
- Poetry $\ln(60 \text{ yrs}) \times 1/3 = 1.3$
- Chemistry $\ln(20\text{yrs}) \times 0.1 = 0.3$
- Optics $\ln(100 \text{ yrs}) \times 1/20 = 0.2$
- Venus $\ln(60 \text{ yrs}) \times 1/5 = 0.8$
- Geography $\ln(60 \text{ yrs}) \times 1/4 = 0.9$
- History $\ln(250 \text{ yrs}) \times 1/10 = 0.5$

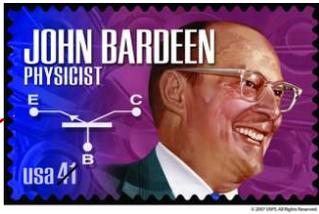
TOTAL $G = 7 \pm 2$

Genius Coefficients $G = T \times B \times D$

• Scientist(me) **~0.03**

• Inventors **0.1-2**

• Nobelists **0.3-4**



• Pithagoras, Aristotle, Newton, Lomonosov, Einstein **4-9**

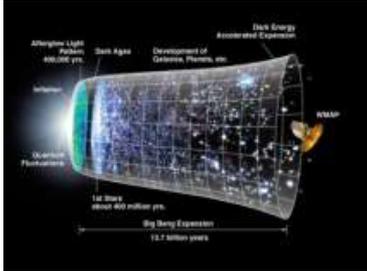
• Sheakespeare, Pushkin **7-12**



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

• **Biblical God** **123**

• **Big Bang** **300-650**

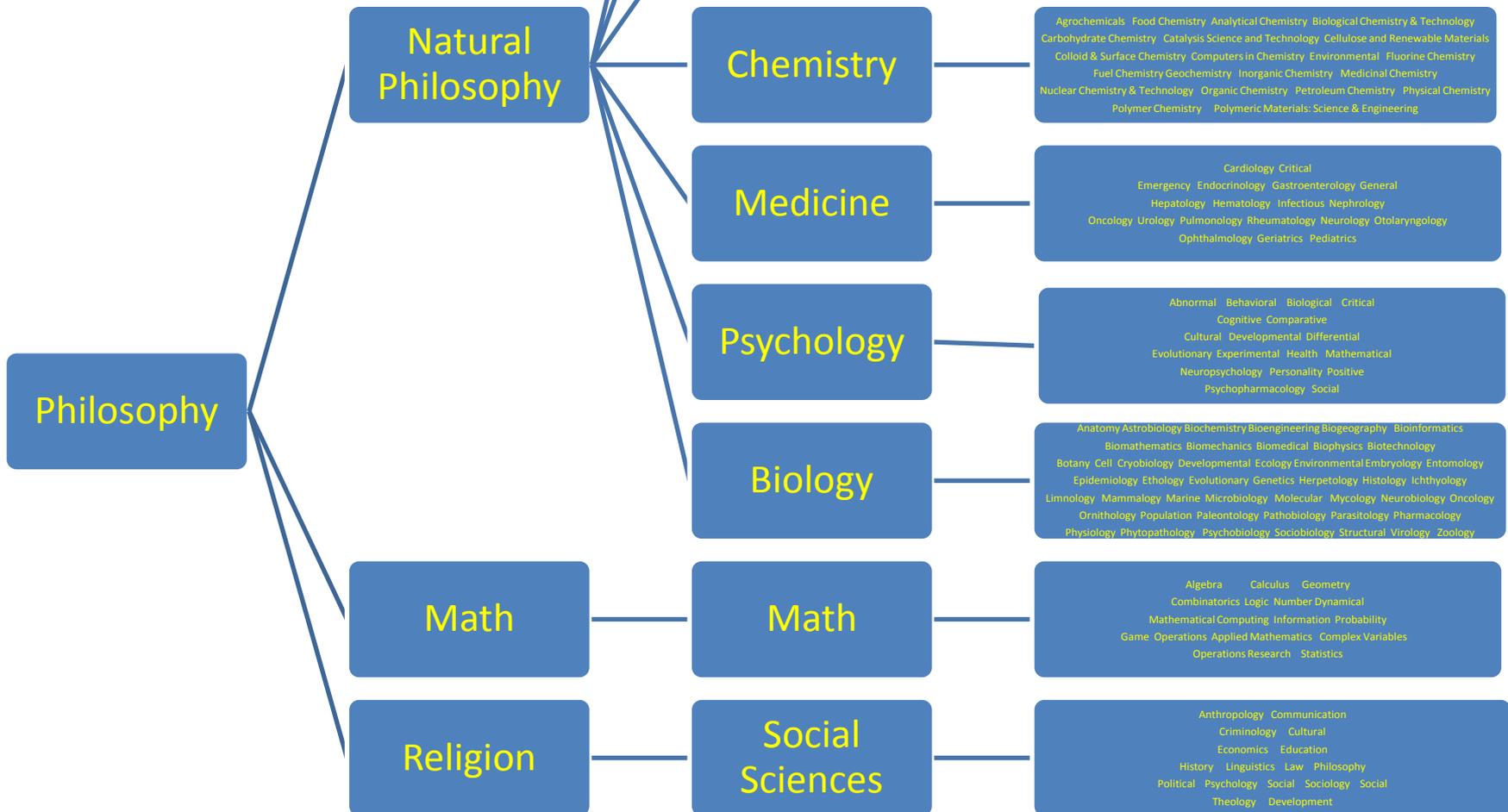


$$\ln(14 \text{ BYrs}) \times \ln(10^6)$$

~200 sciences

Global Genius Product

GGP ~ (4-10) per year



Limitations of the “Genius Formula”

$$\ln(T) \times B \times \ln(\text{After/Before})$$

- how to account geniuses in art, music, etc?
- Baseline choice issue

- eg (my) family of 4 with two kids
- by my definition



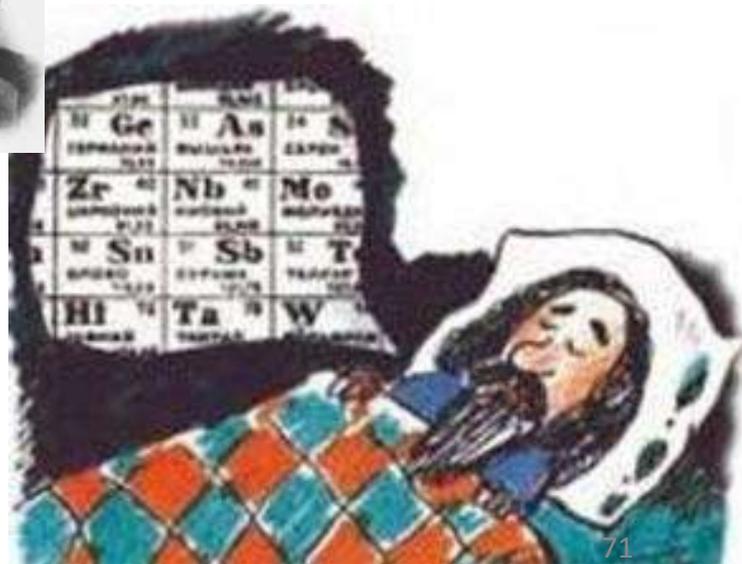
$$G = \ln(13\text{yrs}) \times 2\text{kids} \times \ln([7B+1]/7B) = 1 \times 10^{-9}$$

- by (my wife’s) definition

$$G = \ln(13\text{yrs}) \times 2\text{kids} \times \ln(4/2) = 3.5$$

Other Characteristics of a Genius

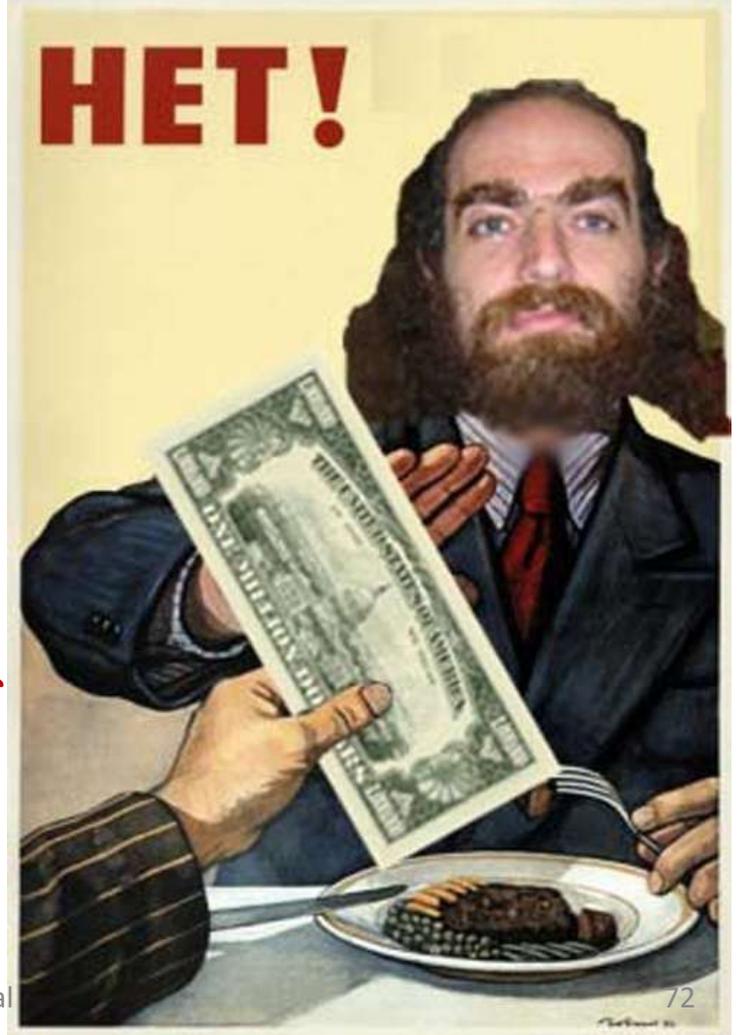
Every Genius Has (Impressive) Story!





Grigory Perelman

- Proved soul theory of manifolds 1994
- Declined European Math Prize 1996
- Solved Poincare Conjecture 2002
- Declined Fields Medal 2004
- Declined 1M\$ Clay Prize 2010
- Refused Academy Position 2011



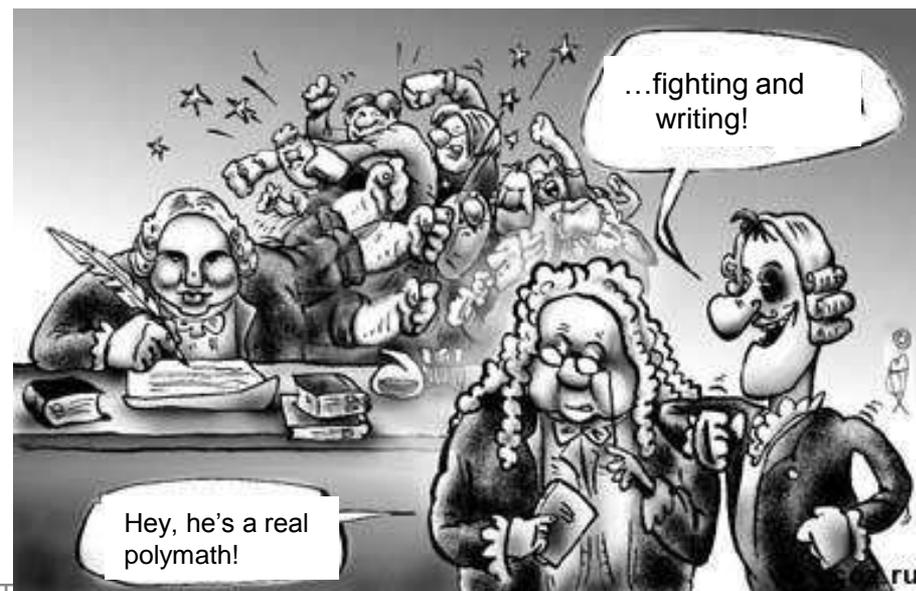
German hussars
enlist drunk
Lomonosov to the
service of the King
of Prussia



Lomonosov's prophetic dream about his father



Three sailors' attempt to rob Lomonosov



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

Robert R. Wilson

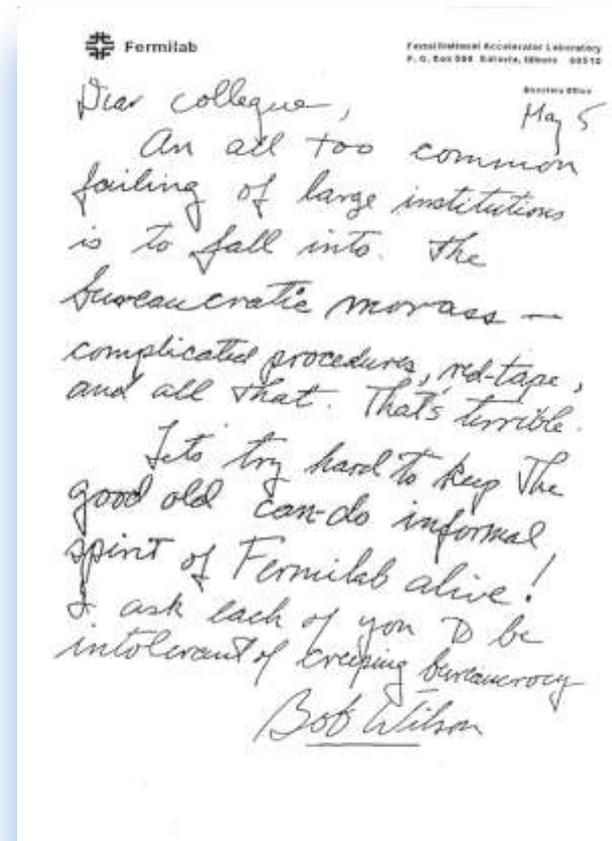
(1914–2000)



Accelerator director quits over cash shortage

The Universities Research Association, which runs the US Fermi National Accelerator Laboratory (Fermilab), has accepted the resignation of Dr Robert R. Wilson. Wilson, Fermilab's director, quit as a protest against the US government's refusal to fund the early completion of equipment to raise the proton beam energies at the accelerator.

New Scientist 2 March 1978



Final Words...

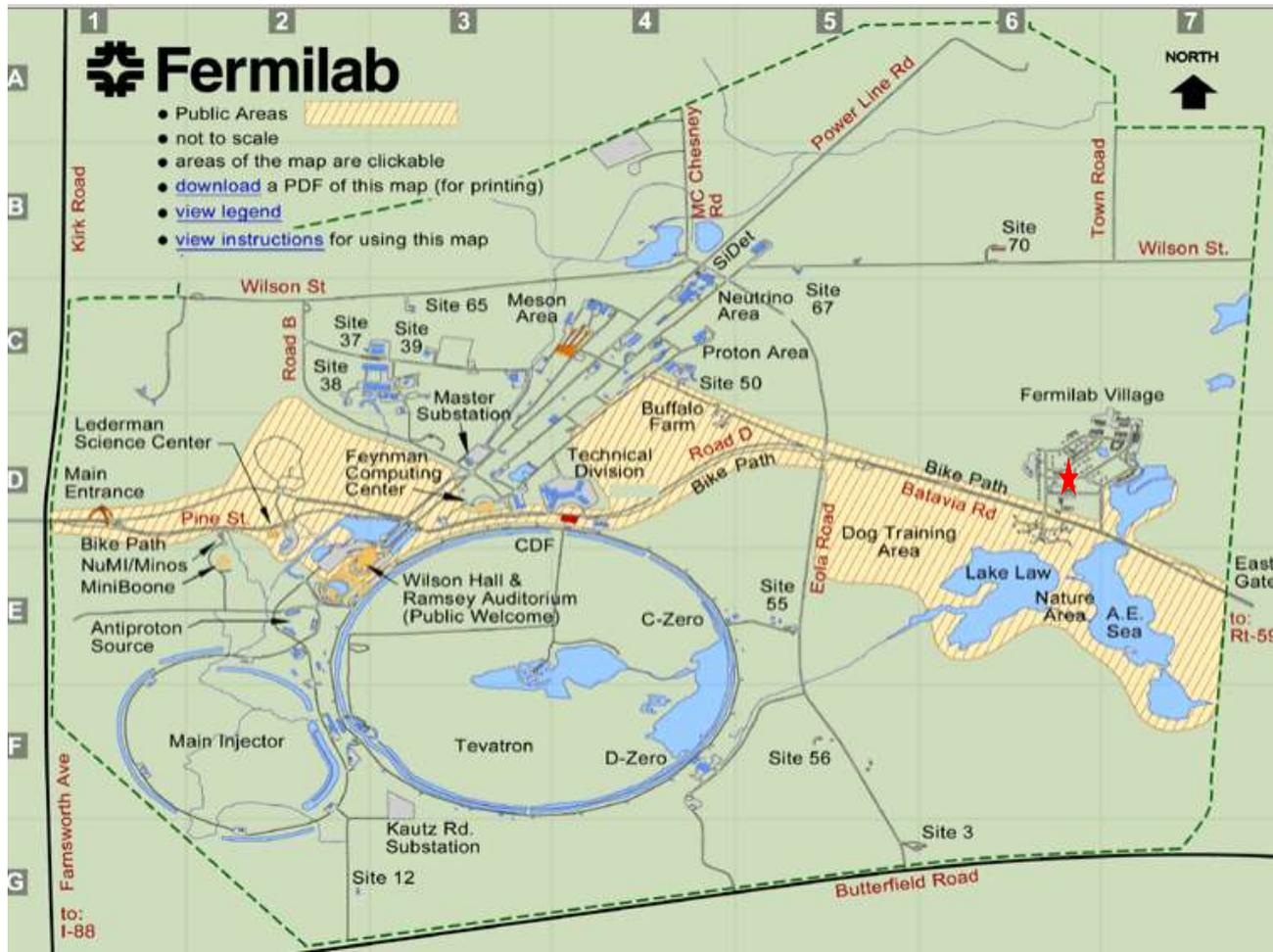
- The system of entire humankind is very complex
 - Both in terms of hierarchy of connections and C -coefficients
- We see that it is progressing, moving somewhere
 - Generates new knowledge, ideas, arts, inventions, etc
- It's not fully clear yet how world's genius (GGP - global genius product) is created
 - 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!*

Backup slides

- Everyone is welcome to taste Russian bread and *kvass*
- Discussion will move to Fermilab Users' Center



Mikhail

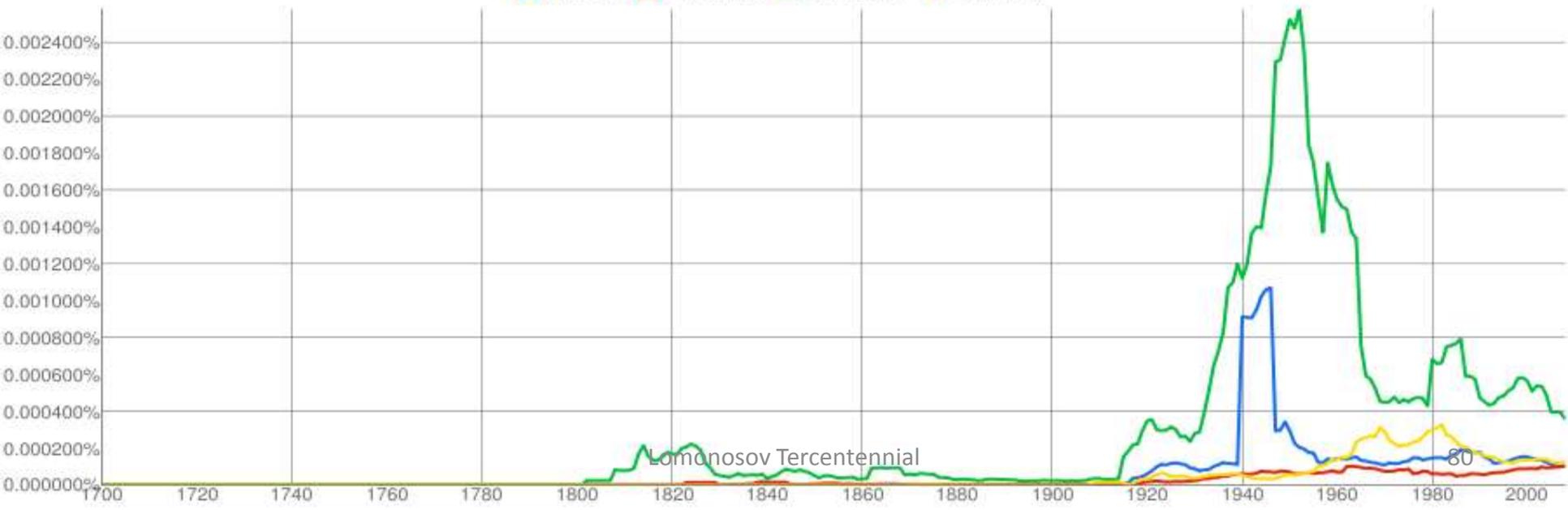
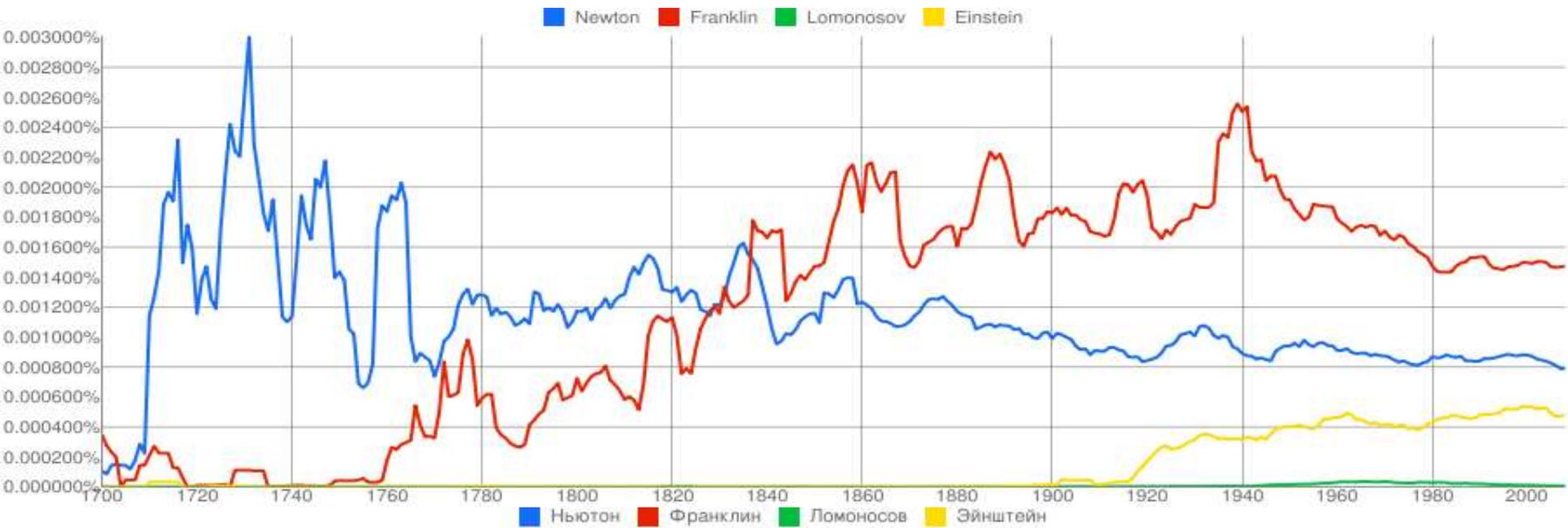
LOMONOSOV

1711-1765



Lomonosov Tercentennial

Geniuses





Movie “Mikhail Lomonosov”

- http://www.youtube.com/watch?v=hvYoGI7KPY8&feature=player_detailpage
-
- <http://www.youtube.com/watch?v=hvYoGI7KPY8&feature=related>

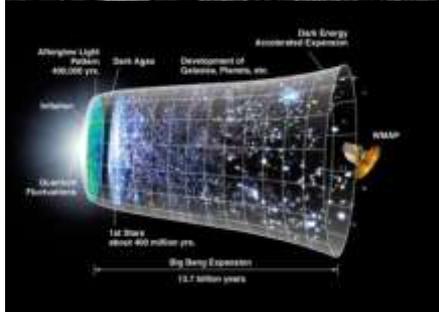
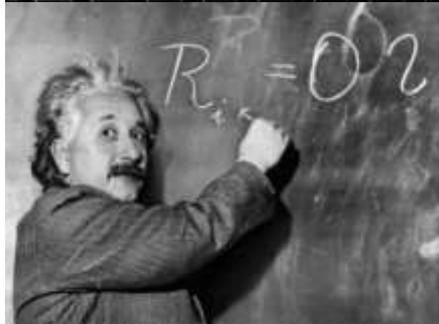
Genius = T × B × D

$$= 15\text{yrs} \times 3\text{kids} \times \ln(7B + 1/7B) = 7 \times 10^{-9}$$

$$= 106\text{yrs} \times 1 \times \ln(4) = 147$$

$$= 7519\text{yrs} \times 6 \times \ln(10) = 103,000$$

$$= 14 \times 10^9\text{yrs} \times 1 \times \ln(10^6) = 2 \times 10^{11}$$

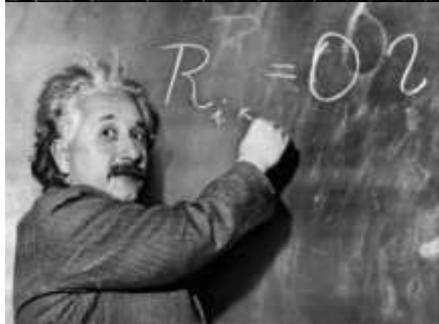


$$Genius = T \times B \times D \quad \text{or} \quad \ln(T) \times B \times D$$



$$= 7 \times 10^{-9}$$

$$= 1.2 \times 10^{-9}$$



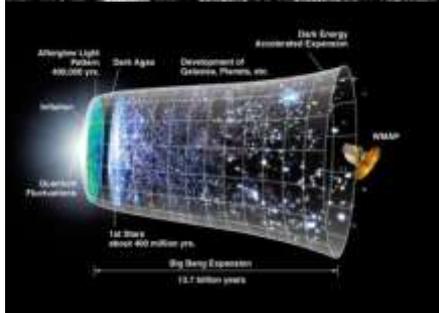
$$= 147$$

$$= 6.5$$



$$= 103,000$$

$$= 123$$



$$= 2 \times 10^{11}$$

$$= 656$$

Lomonosov's Porcelain Factory



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

Lomonosov's Scientific Legacy

- Not that well known in the West
 - Yes, was elected Foreign member of Swedish Academy and Bologna Academy , but for “arts/poetry”
 - Suggested for French Academy in 1765 but died
- Huge name in Russia:
 - but only since 1850's, and even more since after 1910's
- Reasons:
 - No personal contacts/visits in Europe (like, e.g., Franklin)
 - Rare correspondence, eg mostly via Euler in 1748-1765 (6 letters)
 - To a degree, misjudgment: toward foreigners in Russia, and vice versa
 - Major works published in Russia (though ½ in Latin and German, ½ in Russian)
 - Died too early (at the age of 53 ... Franklin -84, Euler – 78)
 - Social, organizational and administrative duties
 - No scientific school, only one daughter (vs 4 generations of Euler's)
 - **Lack/absence of world class scientific community**
 - **Applied science orientation and enormous breadth of interests**