The ERC: a contribution to society and the knowledge-based economy

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Keynote speech

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Forecasting the position of Europe in the Nobel prize competition

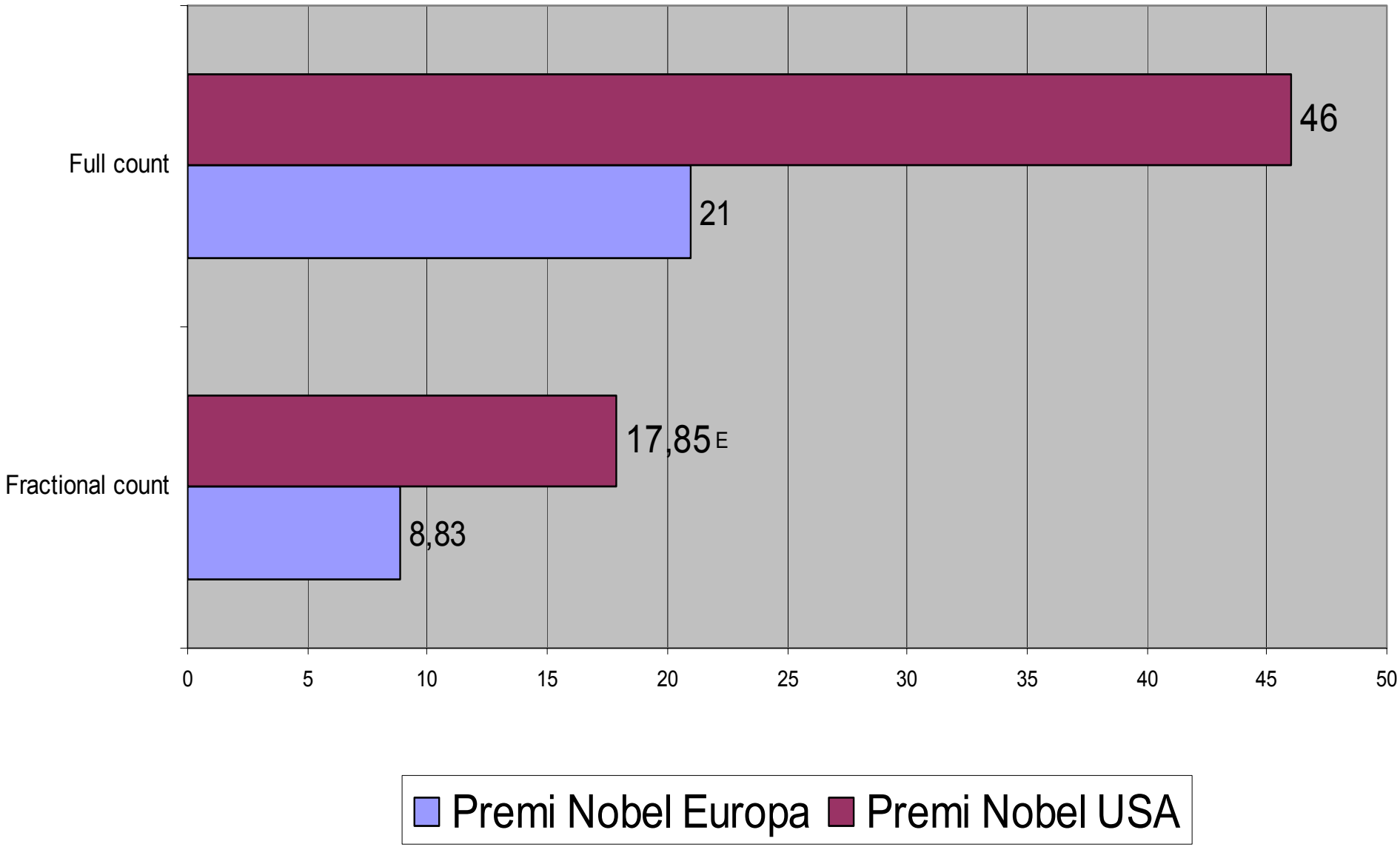
Cesare Marchetti, The Nobel saga, *Technology Review*, September 1989

"it is possible to calculate how many Nobel prizes Europeans and Americans will win.

The Americans will be in minority.
To give an idea, **Europeans should receive 20 prizes in the period between 1989 and 2000, and Americans only 13**.

In ten years time we will meet to check this prediction" (p.11).

Distribution of Nobel prizes in Physics, Chemistry, Medicine. Year 1990-2000



Upper tail in quality of research

Europe lags behind in the ranking of highly cited scientists in the 1981-1999 period in all 21 scientific areas.

In the last part of XX century new scientific fields have emerged or consolidated that have an internal dynamics which creates totally new challenges:

- information
- life
- materials

sciences and their combinations (e.g. cognitive and neurosciences, nanosciences, biorobotics…).

The loss of leadership in top science makes it visible, with a lag of 20-30 years, the difficulty of European science to lead the new scientific fields.

Stylized facts in late XX century- early XXI century science

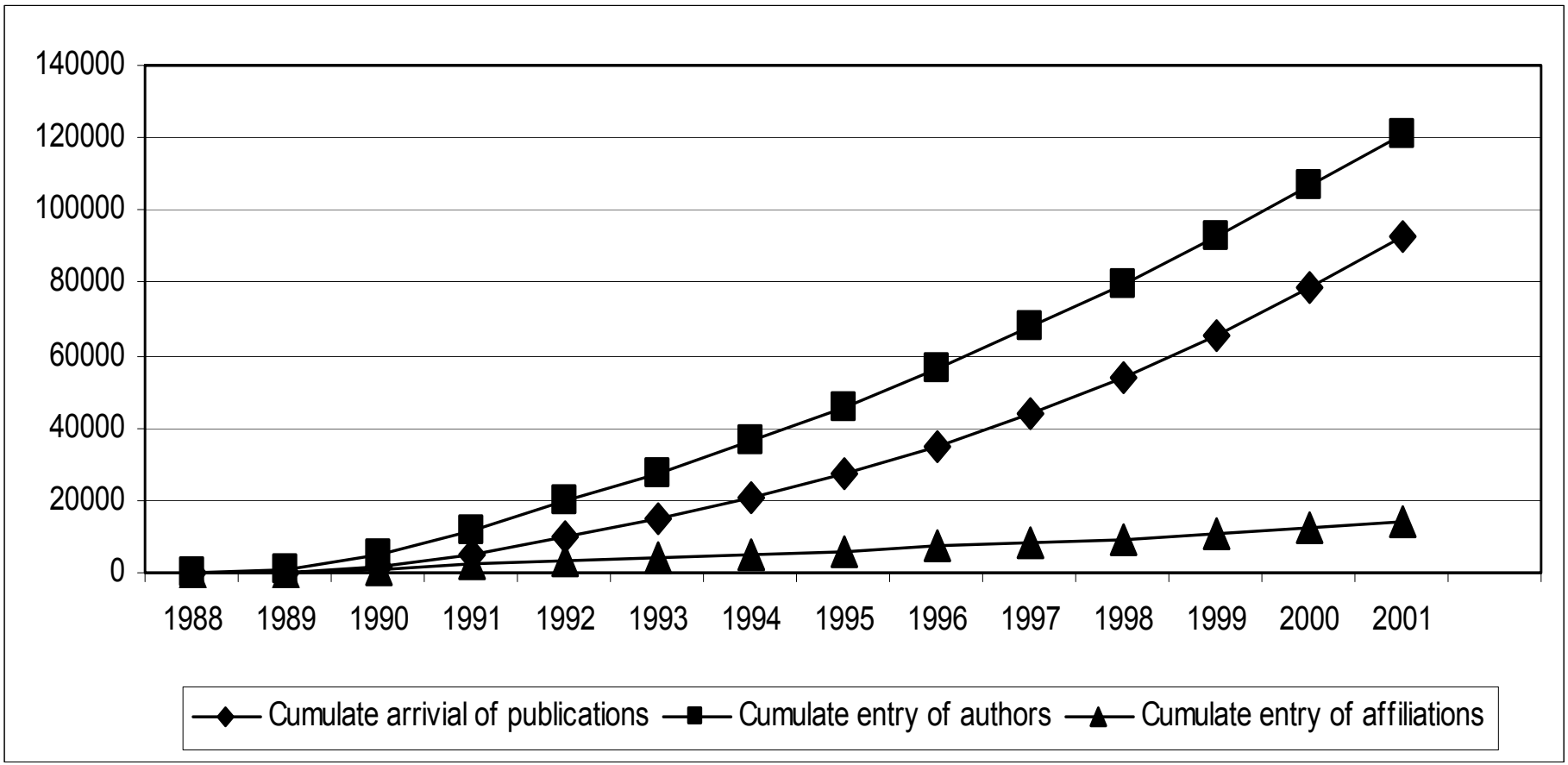
Three main features

- **Acceleration** in the rate of growth of production of scientific results

- **Proliferation of diversity** in scientific programmes

- New forms of **complementarity** in research

Fast growth in Nanopublications



Source: Bonaccorsi and Thoma (2007)

High rate of growth

Average rate of growth of scientific production is 1-2% per year. Fast moving fields grow 5-15% per year. A growth rate of 5% for many years means destabilisation.

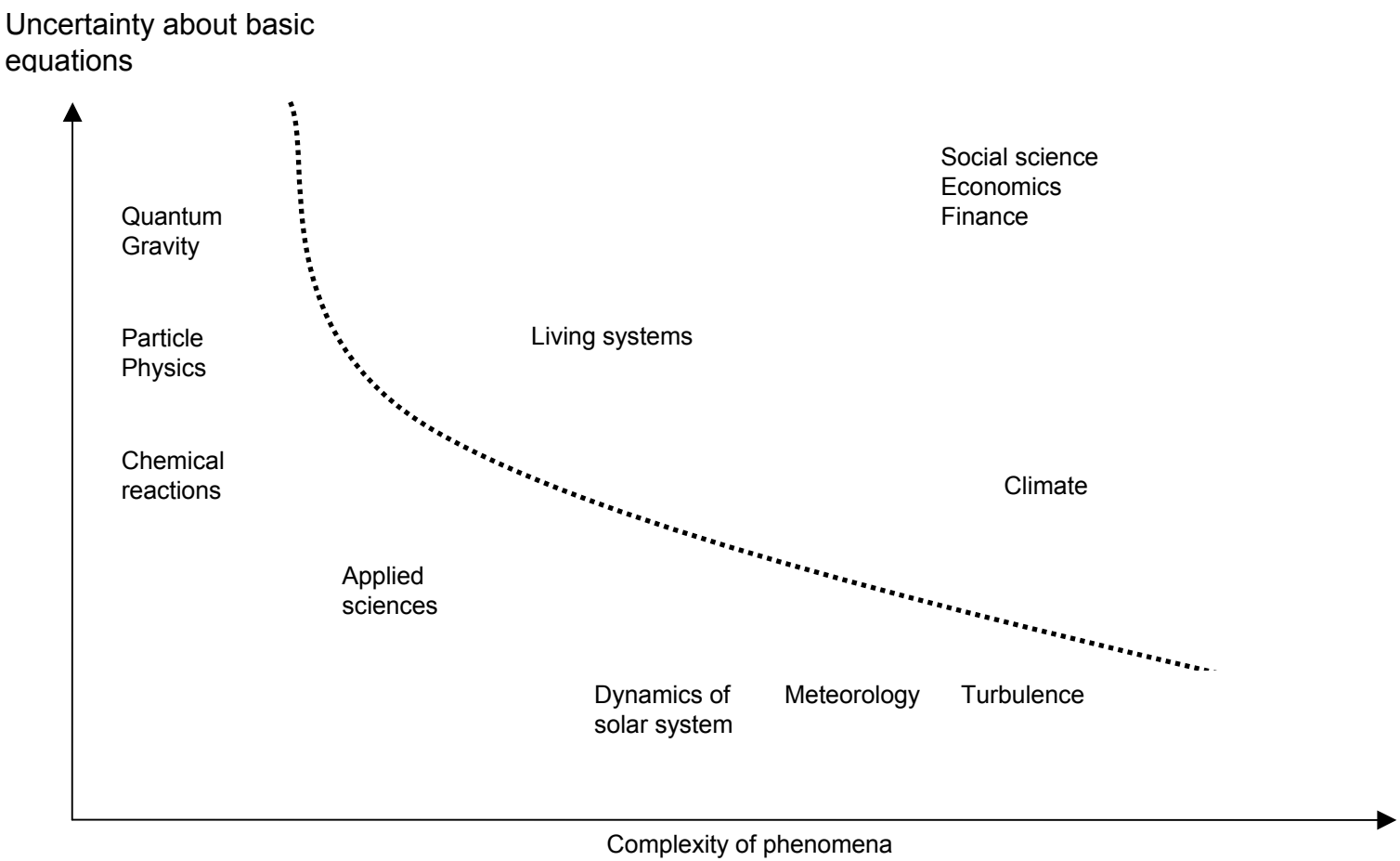
These fields are most likely found in new sciences (information, life, materials, nano).

Implications

- Need for rapidity of decisions in **priority setting** at government level
- Mechanisms for **rapid growth of research labs** or institutes (funding, staff)
- Extremely high opportunity costs for junior scientists
- High **mobility** in research careers

In computer science, top 1000 scientists of the world have changed their affiliation 4.5 times in their career.
Four US universities (MIT, Stanford, Berkeley, Carnegie Mellon) account for almost 20% of changes of affiliation of top scientists worldwide.

The uncertainty- complexity map



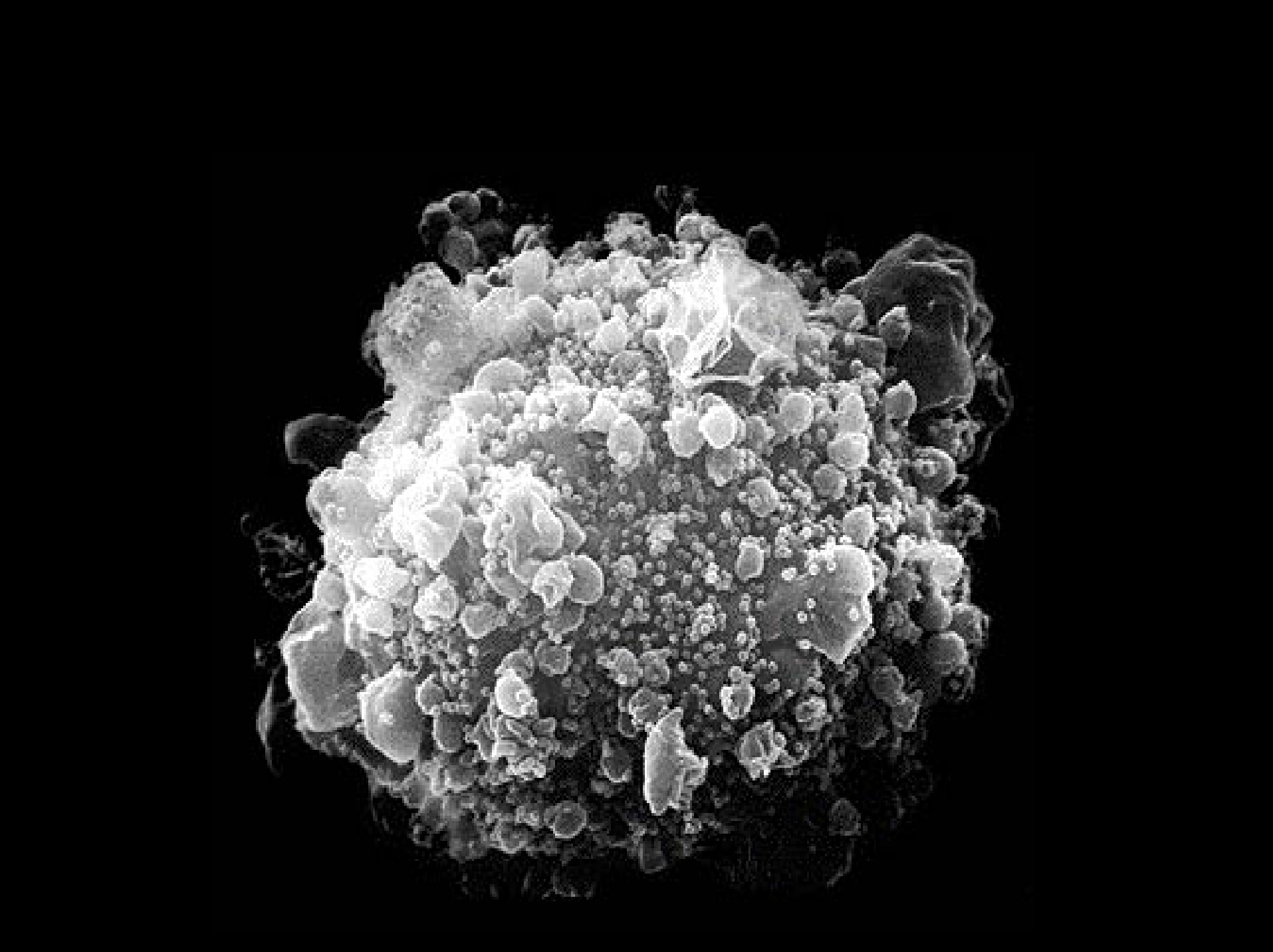
Source: Barrow (1998) after Ruelle

What happens when methodological reductionism in explanation is applied to complex systems?

Reductionist approach: **explaining higher levels of organization of matter using knowledge of lower levels.**

Interestingly, when applied to complex objects or systems (i.e. proteins, or cells, tissues, organs) and their behavior (e.g. disease) the reductionist approach does not lead to a reduction in the number of theories needed.

Rather, **it generates a proliferation of sub-theories**, i.e. it does not reduce but rather increases epistemic uncertainty.



Proliferation pattern

- Impossibility to decide research directions in a **centralized way**- multilayer governance and funding systems
- Strong **epistemic uncertainty**- premium given to top quality universities (signaling effect)
- Need to **finance competing research projects**- variety of funding sources
- Need to **mobilize research projects in parallel**- well developed post doc system
- **Large cognitive distance** between senior scientists and junior scientists- doctoral education based on competition between proposals

New relations between science, technology and innovation

A recent study on knowledge flows from academic research to firms

Dataset (1981-1999)

- in their publications top 200 firms **make approx. 1 million citations to publications of top 110 universities** and 600.000 citations to industrial publications

- in advanced industries (Software and business services, Communications services, Computers) **between 40% and 50% of citations made by companies point to publications in Physics**.

Source : Adams e Clemmons (2006)

New forms of complementarity (in particular, between science and industry)

New sciences make it possible **new combinations between scientific explanation** (knowing the properties of nature) **and engineering** (manipulating nature for a purpose).

New relations between natural and artificial, discovery and invention:
- the fundamental properties of matter cannot be discovered unless a specific configuration is *designed*
-"scientists become engineers"

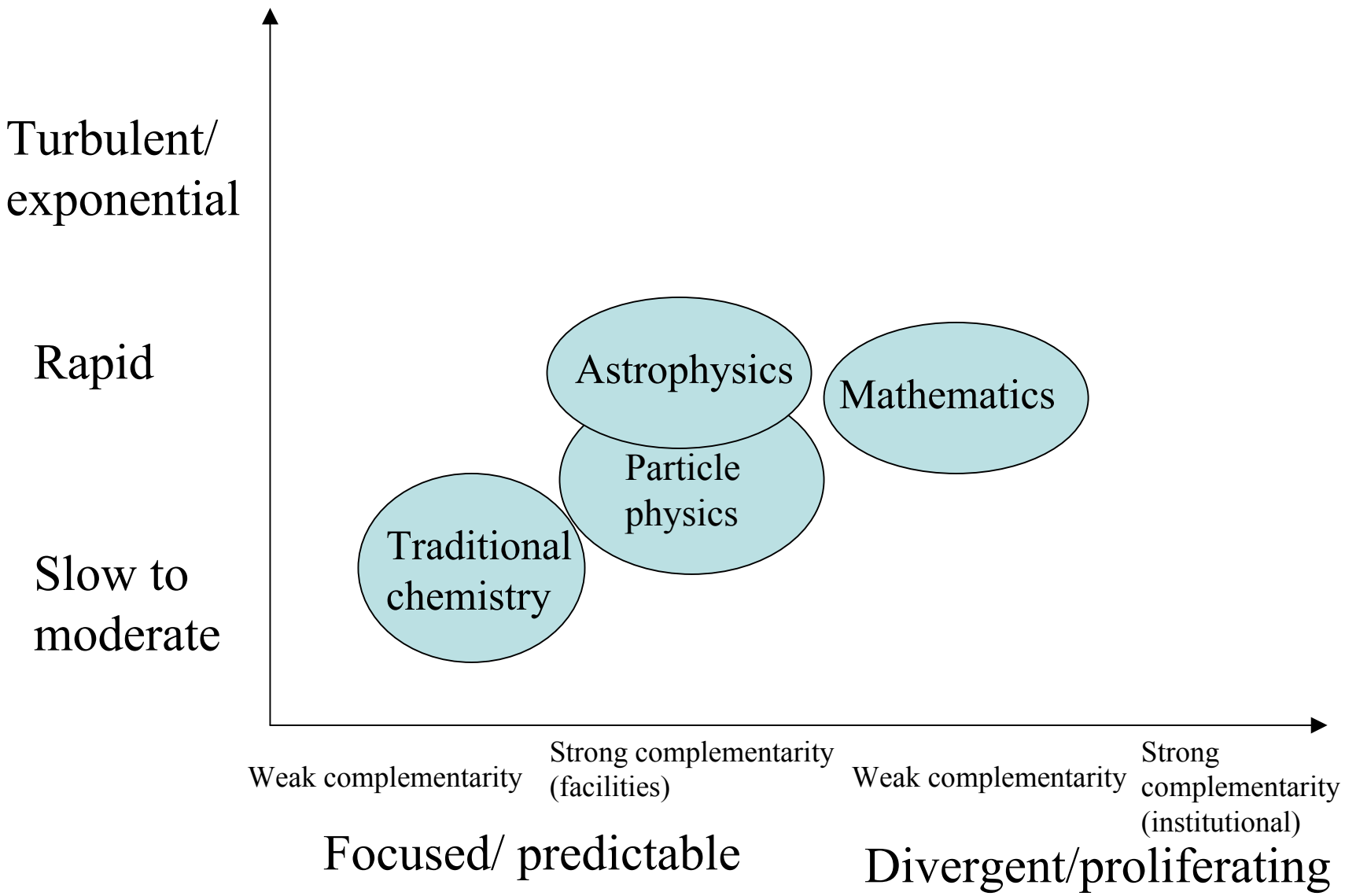
The rise of science-driven engineering

Why should industry be interested in the ERC?

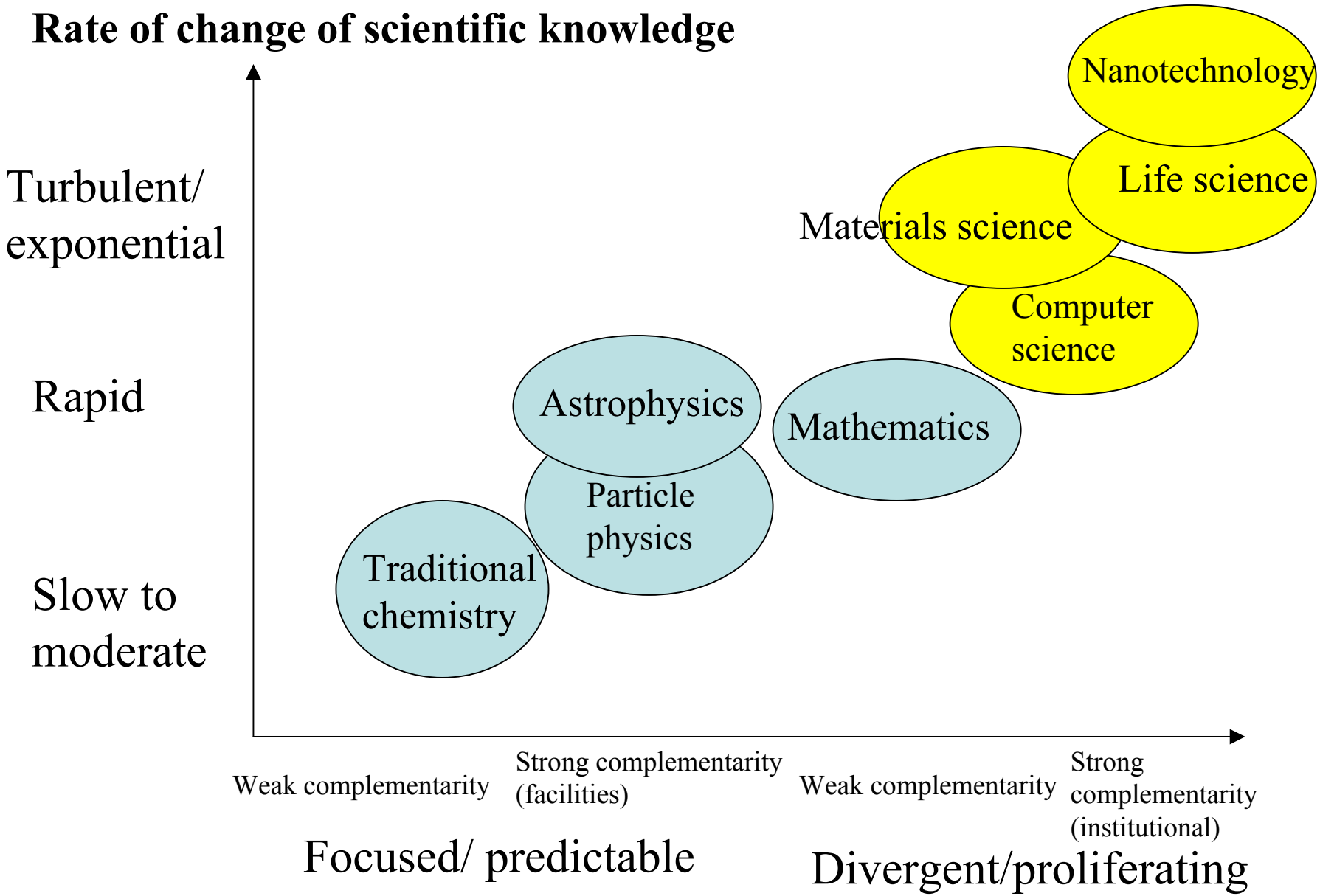
1. Industry invests largely in new leading sciences
   - 50% of top R&D spending companies (IPTS Industrial R&D Scoreboard) are actively involved into nanoscience and technology
   - impressive amount of university-industry collaboration in nanotechnology
   - need to access talented but also creative people, trained in addressing frontier problems

2. Change in R&D models in large firms
   - Decline of large centralized labs
   - R&D at business unit level facing increasingly complex technological challenges
   - Centrality of the need for accessing external knowledge (with the appropriate timing, language, accessibility)

3. Challenge of accessibility of knowledge
   - economists obsessed with appropriability, but in fast moving fields learning is more important than preventing others from using knowledge



Dynamics of change of scientific knowledge and type of complementarity



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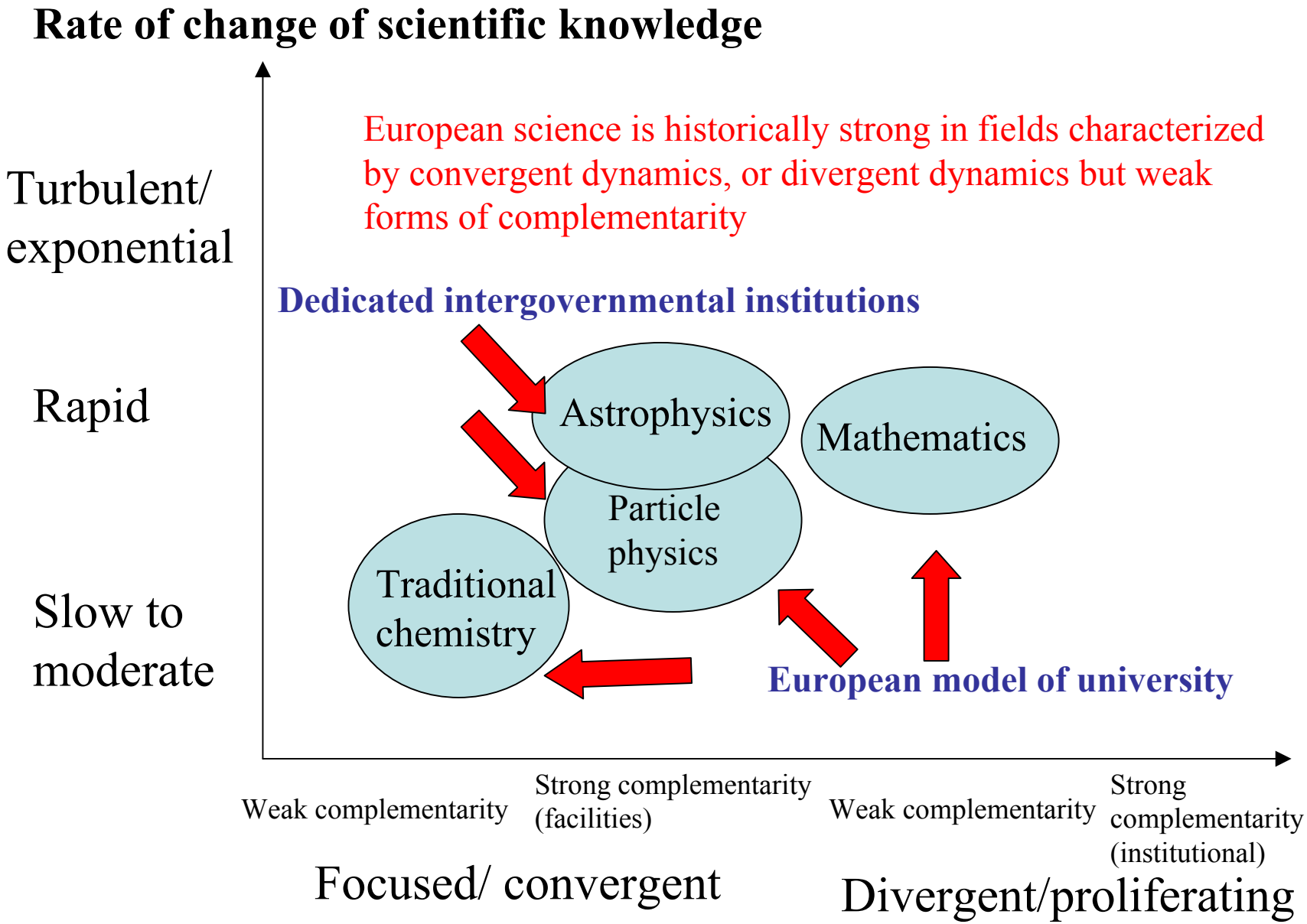

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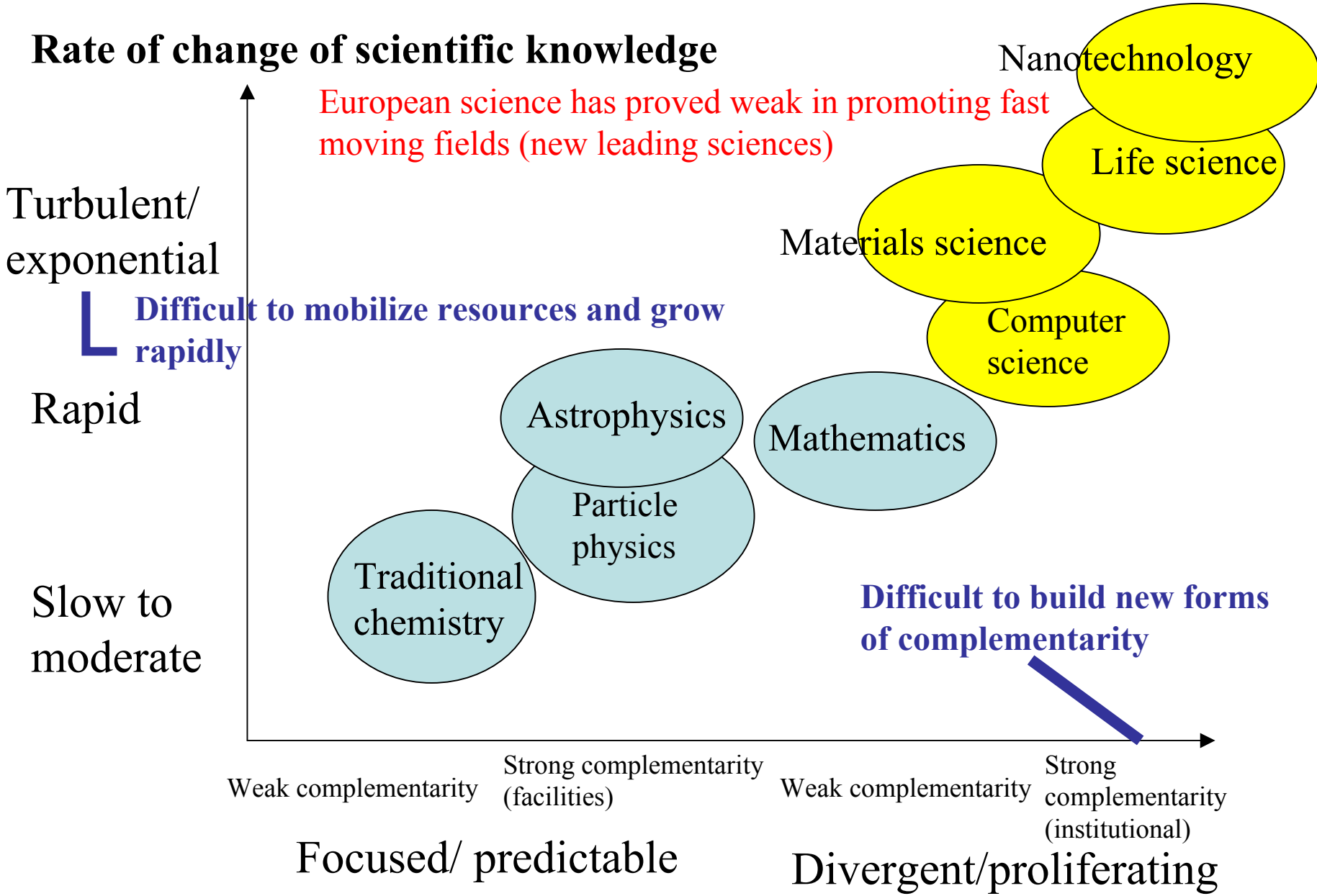

Dynamics of change of scientific knowledge and type of complementarity

But then…

- European relative under performance is the result of a deterioration in the last 20-30 years. Taking the lead will require a long period.
- ERC provides the right starting point
- At the same time **it does not solve per se the issue of fragmentation and lack of coordination** between government strategies and funding agencies at national level
- Two models are possible: (a) top down substitution for national funding (federal model); (b) bottom up policy coordination.
- The way is open.