

# The Problem of the Unsolved Problems<sup>1</sup>

Venice 2024

---

<sup>1</sup>Jürg Fröhlich, formerly at ETH Zurich

# 1. Unsolved Problems in Physics

- ▶ What is **Quantum Mechancis**; do we understand it, after 100 years? How can it be completed to a “theory in final form” (Dirac)?
- ▶ What is **local relativistic quantum theory**? What’s missing in our understanding of this theory?
- ▶ How to reconcile **quantum theory** with **General Relativity**? What is meant by “Quantum Gravity”? Is gravitation a force similar to electromagnetism; or is it something radically different (e.g., an entropic force)? Does it have to be “quantized”?
- ▶ Is the **fundamental dynamics** causal and deterministic, or is it stochastic? Origin of probabilities in Physics?
- ▶ How well do we understand the “**Arrow of Time**” and irreversibility exhibited by many physical phenomena?
- ▶ How well do we understand quantum-mechanical **Many-Body Theory** as the basis of condensed-matter physics?
- ▶ How could one possibly prove **Bose-Einstein Condensation** for translation-invariant Bose gases, phase transitions in magnets ... in the thermodynamic limit?

# More unsolved problems

- ▶ How can we understand the existence of **crystals** and **quasi-crystals** (at zero temperature and in thermal equilibrium)?
- ▶ How to characterize and then establish **dynamical transitions** far from equilibrium? What is meant by “**quantum chaos**”?
- ▶ Big problems of **Cosmology**: How has classical structure formed from the original quantum state of the Universe? Do the fluctuations of the CMB yield information concerning this question? How and when did galaxies form; are there finitely many typical shapes of galaxies? Was there an inflationary phase in the evolution of the Universe? What is dark energy; what is dark matter; what is the origin of the tiny, very homogenous magnetic fields extending over intergalactic scales? How are these problems connected to “Physics beyond the Standard Model of Particle Physics”?
- ▶ Problems of **Applied Physics**: Green energy, fusion energy, ...? How could one harvest greenhouse gases from the atmosphere? Can we build programmable quantum computers that could solve **useful** problems? Physics and the Life Sciences. ...

## 2. Bigger Unsolved Problems

To our dismay, it appears that, during the past 100 or more years, humanity has been unable to solve any of the major problems threatening its own survival – if it ever was able. And it is getting ever worse!

Examples of major problems not resolved, as of now:

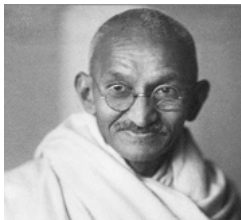
- ▶ The demographic time-bomb - problem known for > 75 years
- ▶ Nuclear disarmament - problem present for the past 75 years
- ▶ Climate change - problem identified > 100 years ago
- ▶ Safe production & storage of clean and renewable energy
- ▶ Excesses of turbo-capitalism & of a dysfunctional monetary system; excessive power of financial- and Tech oligarchs
- ▶ Among many threats to our democracies: Neglect and contempt of cultural values and good traditions; increased polarization in our modern (Western) societies; widening gap between poor and super-rich people; spreading of far-right ideologies
- ▶ Common inability to respect adversaries at home and abroad and to reach good compromises; loss of touch with the foundations- and loss of understanding of the functioning of our complex societies

# Learning from Great People

- ▶ Fostering secular, enlightened, liberal societies; integration of immigrants from other cultural backgrounds into our societies
- ▶ Equal rights and equal privileges for women
- ▶ Arab-Israeli conflict, conflicts in Palestine, Syria, ..., Northern Ireland, Catalonia, Eastern Europe, Asia, South America, ...

Incidentally, this list was compiled in the spring of 2019, before the wars in the Ukraine and in the Middle East started.

One should try to learn from people who **did** solve some major problems:



Gandhi



Einstein and Bose



Grothendieck

and from further people I will mention.

## Tomi Ungerer's illustration of Goethe's *"The Sorcerer's Apprentice"*

Humans are a sorcerers' apprentices: Once ideas are born and released, once discoveries and inventions are made public, they have a life of their own, they start to roam around the world, we lose control of them – they may turn against us!



The catastrophe is unfolding



# Example: Nuclear weapons

The Manhattan Project – *Oppenheimer, Feynman, ...*



"Fatman"



*"In some sort of crude sense, which no vulgarity, no humour, no overstatements can quite extinguish, the physicists have known sin; and this is a knowledge which they cannot lose."* (J. R. Oppenheimer)

*"For me the correct question is what one should do, not how one should feel..."* (R. P. Feynman)

## Eisenhower's Warning in his farewell speech as American president (January 1961)



"We annually spend on military security *more* than the net income of *all United States corporations*. This conjunction of an immense military establishment and a large arms industry is new in the American experience. ... **In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex.** The potential for the disastrous rise of misplaced power exists and will persist. **We must never let the weight of this combination endanger our liberties or democratic processes.**"

### 3. People worth listening to

*"Concentrated power is not rendered harmless by the good intentions of those who create it."* (Milton Friedman)

*"The difference between what we do and what we are capable of doing would suffice to solve most of the world's problems."*  
(Mahatma Gandhi)

*"Never doubt that a small group of thoughtful, committed, citizens can change the world."* (Margaret Mead)

*"We had ten years after the Cold War to build a new world order and yet we squandered them. The United States cannot tolerate anyone acting independently. Every US president has to have a war."* (Michail S. Gorbatschow)

Historical experience suggests that Russia cannot tolerate countries in its neighborhood that want to act independently.

## “Survivre et Vivre” – more than half a century later

*“... depuis fin juillet 1970 je consacre la plus grande partie de mon temps en militant pour le mouvement **Survivre**, fondé en juillet à **Montréal**. Son but est la lutte pour la survie de l'espèce humaine, et même de la vie tout court, menacée par le déséquilibre écologique croissant causé par une utilisation indiscriminée de la science et de la technologie et par des mécanismes sociaux suicidaires, et menacée également par des conflits militaires liés à la prolifération des appareils militaires et des industries d'armements. ...”* (Alexander Grothendieck)

Have we forgotten his message?



I am not really doing  
research, just trying to  
cultivate myself

Alexander Grothendieck

**Réveillez-vous, indignez-vous, engagez-vous!** (Stéphane Hessel)

#### 4. Is this the present situation of the world?



*Thanks for listening!*