The future of Physics

Lars Strandén, 2011-09-23

Background

If one looks back on the development of physics one can see that the driving force always has been to explain experiments that do not have any established explanation. One obvious example is the Michelson–Morley experiment and the creation of theory of relativity. Opposed to this was the development of Superstring/M-Theory theory which was not initially needed to explain any experiments but instead shed new light on particle physics. However, Superstring/M-Theory allows for 10^{500} universes i.e. 10^{500} versions of physics! This is such a ridiculously high number that it is impossible to grasp. For example, if we would like to analyze all versions during the same time as the age of our universe we have to go through around 10^{482} versions/second to finish the job! However, there is no other real alternative candidate than Superstring/M-Theory and it has been a success in certain cases which implies that Superstring/M-Theory is a valid part of the story.

Theory vs. real life

What are the possible consequences of Superstring/M-Theory as it is today? We can sketch alternatives using parameters *reality* vs *theory* in matrix form as shown below. A matrix element shows the status/consequence according to the corresponding row and column.

Theory Reality	**A theory can be created why our universe is like it is.**	**A theory cannot be created why our universe is like it is.**
There are 10^{500} universes possible.	Breakthrough is first needed	• Anthropic principle, or • Cannot select the correct theory of many, or • Too complex problem
There is a reasonable number of universes possible.	Go through the universes one after another	• Anthropic principle, or • Cannot select the correct theory of many, or • Too complex problem
There is just one universe possible.	The perfect case	• Anthropic principle, or • Too complex problem

For Reality:

- *Breakthrough is first needed* – some revolutionary idea(s) must show up in order to remove the enormous number of possible universes.
- *Go through the universes one after another* – if not too many each can hopefully be worked through
- *The perfect case* – we are home

For Theory:

- *Anthropic principle* – this means that we live here because our universe is the only possible one for allowing creation of intelligent life. That is, another version of a universe and we would not be there to see it.

- *Cannot select the correct theory of many* – e.g. experiments cannot be made to separate out the correct theory due to economics, high energies needed etc.
- *Too complex problem* – there is no mathematics and/or principles possible/available.

Theory verification

Generally, the interest in fundamental physics concerns the extremely large and the extremely small. We can see that they meet especially when discussing black holes and big bang. The two extremes also raise the same problem concerning experiments and their capabilities but in different ways. The basic question is; how can we verify theories? We can separate two independent aspects; *scope* and *method* and for *scope* we have:

- Whole theory – enough can be verified in order to rule out competing theories and to verify that there are no inconsistencies. This also includes suggestions of new verification cases and verifying that their results are as expected.
- Only part of theory – strengthens the theory. There are no visible inconsistencies.
- No part of theory – nothing can be verified.

for *method* we have:

- Experiment – use of tools for performing physical tests.
- Analysis – this includes analysis of e.g. deep space data. This also includes calculations that can be compared with other calculations. An example is the calculation of entropy of a black hole.
- Simulation – i.e. use computers for behavior evaluation.

In principle, analyses and simulations are always possible but experiments are not. The reason could be due to financial costs and/or high energies needed. The problem is that results from experiments are hard facts that must be included for verifying a theory. The table below shows the alternatives with respect to *scope* and *experiments*. The alternatives for experiments are:

- Possible – economically and physically possible.
- Not possible – economically and/or physically impossible.

In the matrix below an element shows the status according to the corresponding row and column.

Scope **Experiments**	**Whole theory**	**Only part of theory**	**No part of theory**
Possible	Perfect case.	We have to accept that we cannot do better.	Not applicable (contradiction).
Not possible	The theory is suitable for experiments but we cannot perform them.	We have to accept that we cannot do better.	We can only start believing.

For investigating the extremely small we would like to approach Planck scale energy since it makes it possible to analyze quantum gravity. Planck scale energy scale is around 1.22×10^{19} GeV as compared to 1.4×10^{4} GeV for particle energy at LHC CERN which is currently the highest manmade particle energy available. Thus there is a factor 10^{15} between them. Cosmic rays can have energies of over 10^{11} GeV but for collisions with Earth particles they have to be at rest “waiting” for these rare events. The effective energy results in around 10^{6} GeV. The factor to Planck scale energy is thus 10^{13}. The conclusion is that we will be nowhere near Planck scale energies now and not in the future.

We have experimental tools for the extremely small, even if not sufficient, but what about tools for the extremely large? Do we have to create large masses for achieving anything? Maybe we can create small black holes and do some experiments but certainly not any masses comparable to planets and stars. There might be some possibilities when analyzing cosmic particles; some effects that support some theories but we cannot create these particles, we just have to wait for them. Also the enormous distances involved make it impossible to make experiments; the distance relation between our solar systems and the nearest star (four light years away) is 1: 6000. Since the possible speed of a rocket is much lower than speed of light any journey to the nearest star and back is unrealistic. For example, a journey with speed one tenth of speed of light will take 80 years and this speed is about 1000 times faster than current maximum rocket speed.

What requirements can we put on a theory if we are not capable of doing experiments? Is it enough to just have a consistent theory? How much credibility can we add by analyses and simulations? What if we can only verify parts of a theory? If we have more than one consistent theory can we take the most beautiful one or the most simple one or according to some other criteria? Being able to calculate anything at all could be a reason for preferring a theory. Are the recent, more “engineering like” Nobel prizes in physics (hard disk and CCD-sensor) a first sign of lack of needed but not possible experiments for fundamental research?

There are also social aspects to consider. Will there be persons interested in physics if we cannot proceed in verifying theories? Also, one can foresee an increase in religious beliefs; if we cannot perform experiments to know more one could just as well believe in religion. Physics and religion thus meet in believing. One can also foresee an increased interest in biology, chemistry, molecules and atoms research since the tools and possibilities for doing corresponding kinds of experiments increase all the time.

Since tools are available for particles but not for deep space one could hope that particle theories could be used to support theories for the extremely large. Even though the discussion here is quite pessimistic (realistic) let us hope for something truly revolutionary that will open up completely new aspects of physics!