

# How to Build a Universe

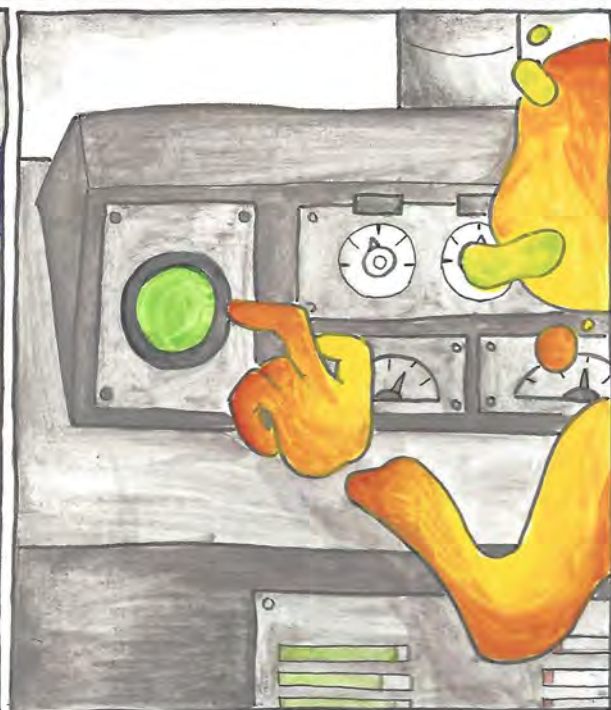
Written by Tim Cohen and Illustrated by Rose Gibian

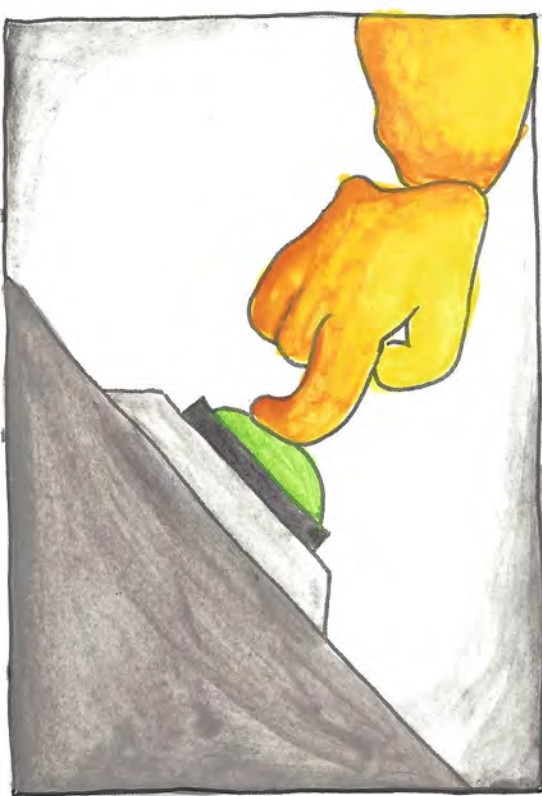
Congratulations! You are now the proud owner of a "Universe Machine," a research device that lets the user experiment with creating different universes that are consistent with the rules of quantum mechanics and special relativity. Here are a list of options you must select before you can attempt to generate a universe:

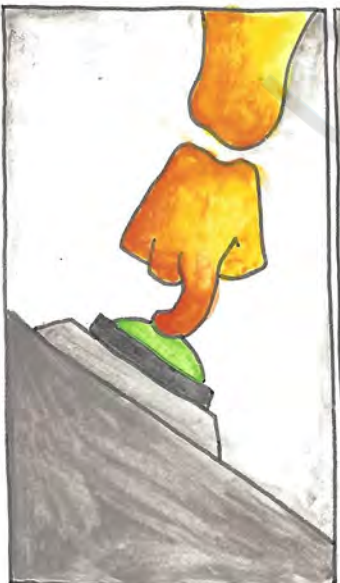
1. Space-time dimension (default = 4)
2. Matter and forces (default = Standard Model)
3. Masses (max =  $M_{pl}$ )
4. Interaction strengths (max =  $4\pi$ )
5. Initial temperature (max =  $M_{pl}$ )

Note: If you include a "Higgs boson" then you might find that the properties of your universe are very (very) sensitive to the Higgs boson mass you choose. If you prefer not to fine-tune this parameter, we recommend upgrading your machine by adding "supersymmetry" particles.

**WARNING:** Adjusting the "cosmological constant" nob voids the warranty.









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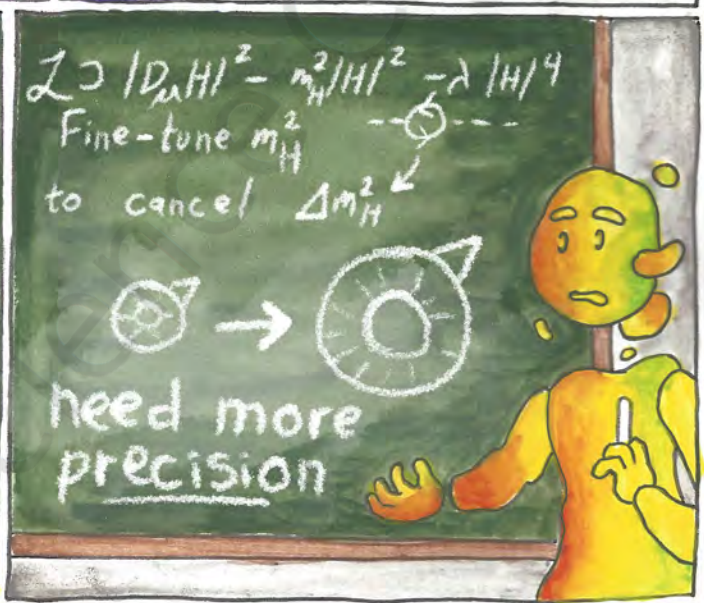
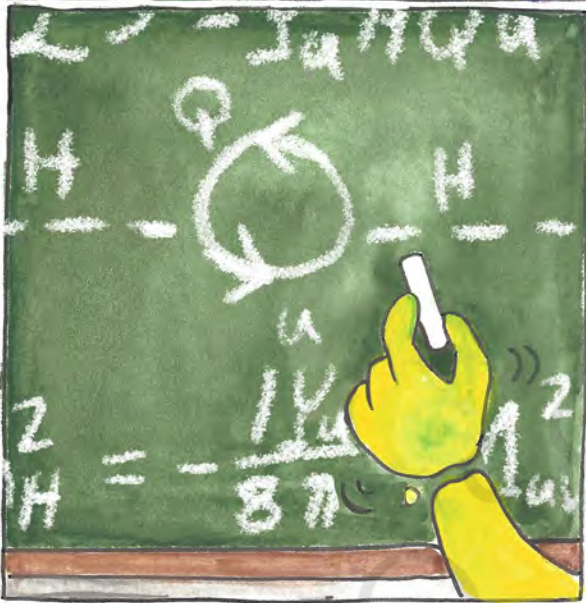
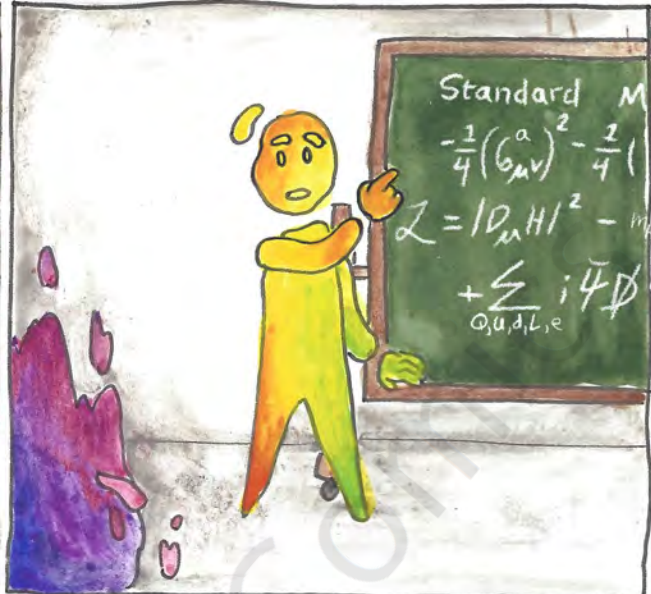
WARNING: Adjusting the "cosmological constant" voids the warranty.

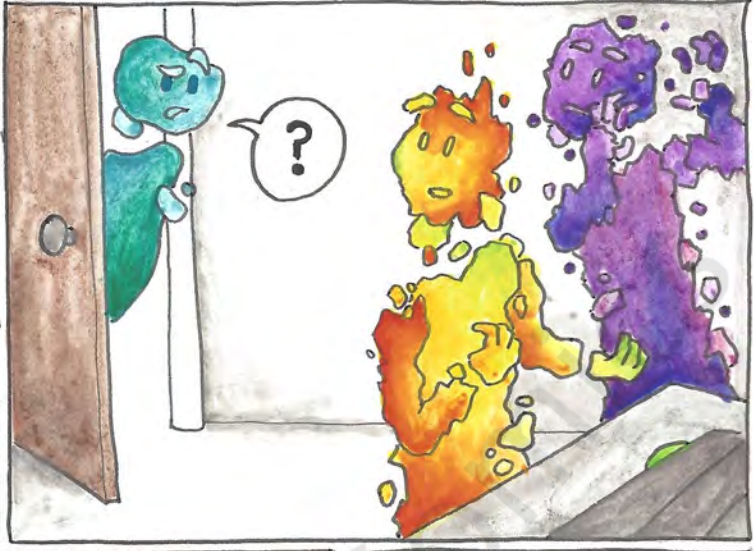
$(G_{\mu\nu})^{-\frac{1}{4}} (W_{\mu\nu})^{-\frac{1}{4}} B_{\mu\nu}^2$   
 $\mathcal{L} = |D_{\mu}H|^2 - m_H^2 |H|^2 - \lambda |H|^4$

adjust Higgs Mass

$-Y_u H Q$







### Particles

<input checked="" type="checkbox"/>	up
<input checked="" type="checkbox"/>	down
<input checked="" type="checkbox"/>	electron
<input checked="" type="checkbox"/>	electron neutrino
<input checked="" type="checkbox"/>	muon
<input checked="" type="checkbox"/>	muon neutrino
<input checked="" type="checkbox"/>	tau
<input checked="" type="checkbox"/>	top
<input checked="" type="checkbox"/>	bottom
<input checked="" type="checkbox"/>	strange

### Superpartners

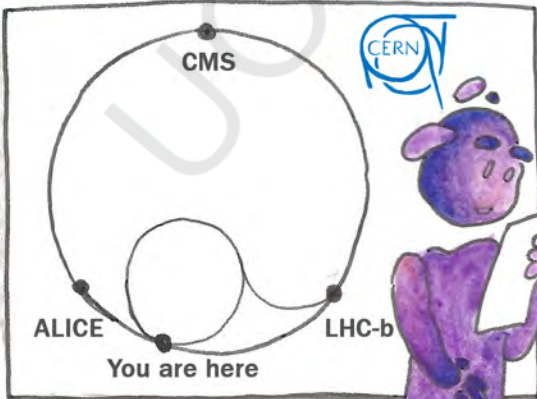
<input type="checkbox"/>	up	sup
<input type="checkbox"/>	down	sdown
<input type="checkbox"/>	electron	selectron
<input type="checkbox"/>	electron neutrino	selectron neutrino
<input type="checkbox"/>	muon	smuon
<input type="checkbox"/>	muon neutrino	smuon neutrino
<input type="checkbox"/>	tau	stau
<input type="checkbox"/>	top	stop
<input type="checkbox"/>	bottom	sbottom
<input type="checkbox"/>	charm	scharm
<input type="checkbox"/>	strange	sstrange





 EXIT

Welcome to the **ATLAS Station**

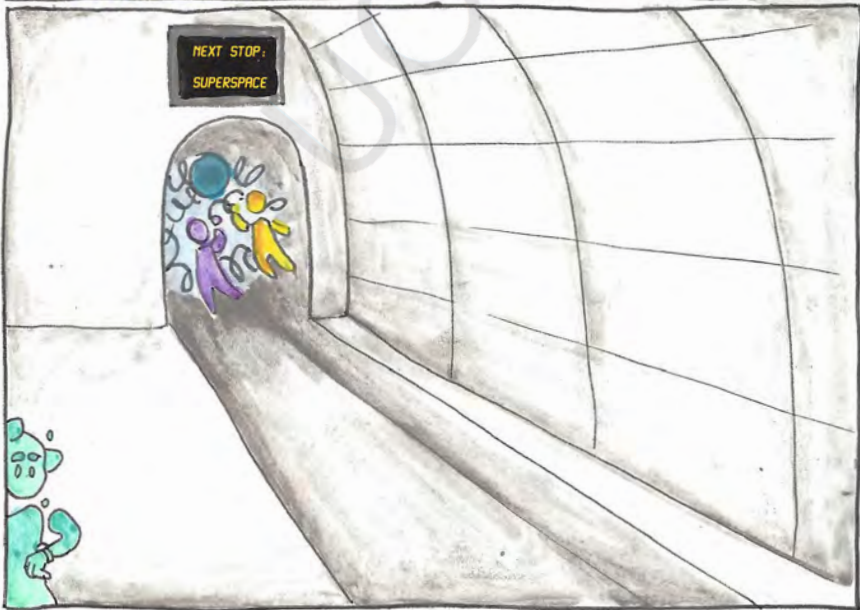
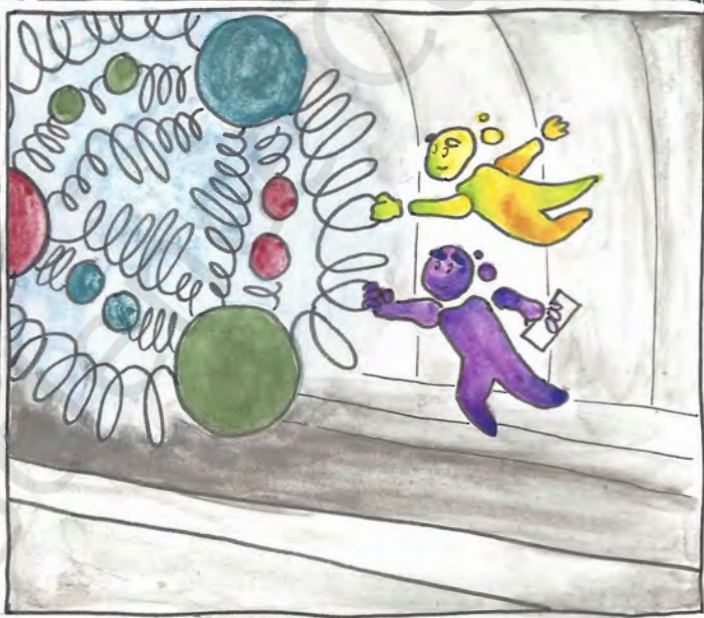
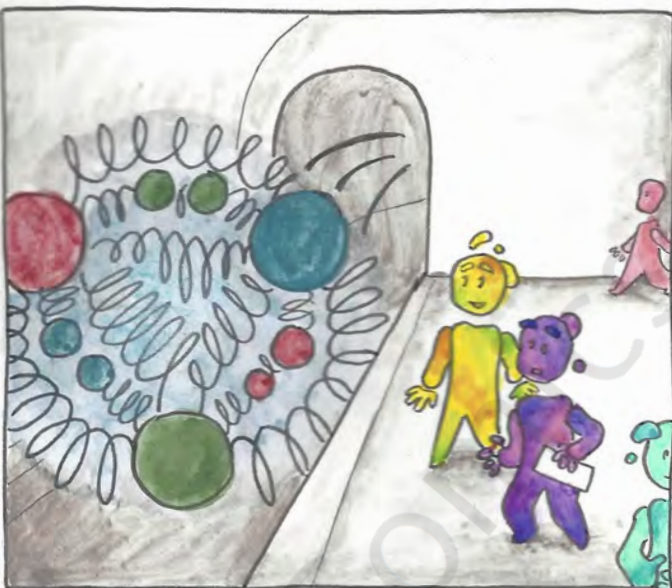



## DEPARTURES

- PROTON ... 25 NANoseconds
- PROTON ... 50 NANoseconds
- PROTON ... 75 NANoseconds
- PROTON ... 100 NANoseconds
- PROTON ... 125 NANoseconds









## PHYS 391 Advanced Physics Lab: Final Project Report

Our goal this quarter was to combine the rules of quantum mechanics and special relativity to generate a fully functional universe from first principles using the "Universe Machine" technology.

We began by working in 4 space-time dimensions and simply using the particles and forces of the so-called "Standard Model of Particle Physics."

We were able to make the machine run. However, it would generate universes that were devoid of life. We re-read the manual and noted that one issue might be how carefully we were adjusting the mass of the Higgs boson. However, no matter how large of a nob we attached to the machine in order to fine-tune this value, we were still unable to achieve our goal of a habitable universe.

As future work, we are planning to introduce supersymmetry into our machine, which we expect will significantly reduce the need to fine-tune. To this end, we have traveled to the Large Hadron Collider. Using the ATLAS experiment, we are currently en route to "superspace."

Although we have not yet been able to detect any supersymmetry particles directly, we remain optimistic that persistence will pay off. Soon we should have the necessary ingredients required to naturally generate stable universes that are capable of supporting life.

End