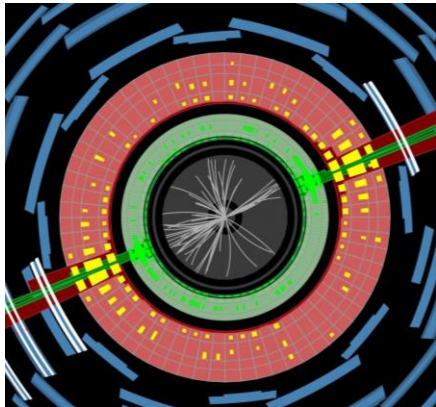


# Particle Physics for the Future



Jon Butterworth  
University College London  
*Universal Science, ICHEP*  
August 2020



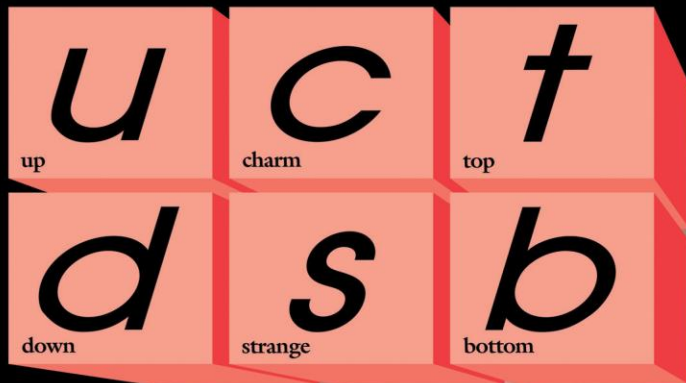
# Why keep doing Particle Physics?

- Sometimes it seems to be about
  - Building bigger & bigger (& more expensive) machines to chase down slippery theories
  - Devising ever more abstruse and intricate ways to measure arcane things more precisely
- **Even if** that were the full story...
  - Provides objective (and peaceful) challenges to test ourselves against
  - Drives and exploits technological development
  - Drives and exploits international cooperation

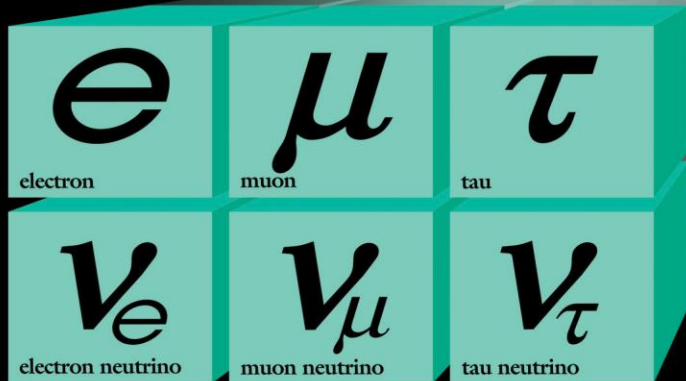
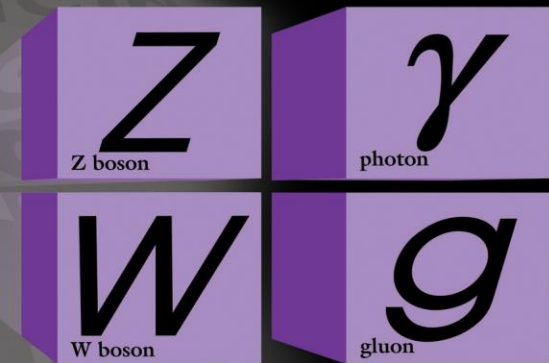
# Why keep doing Particle Physics?

- But that is not the story
- It is about, and has always been about, **exploration**
  - How does the universe work and what is it made of? What are the underlying principles?
  - What are the fundamental constituents and forces of nature?
- This is the common goal, that also brings the wider benefits

# Quarks

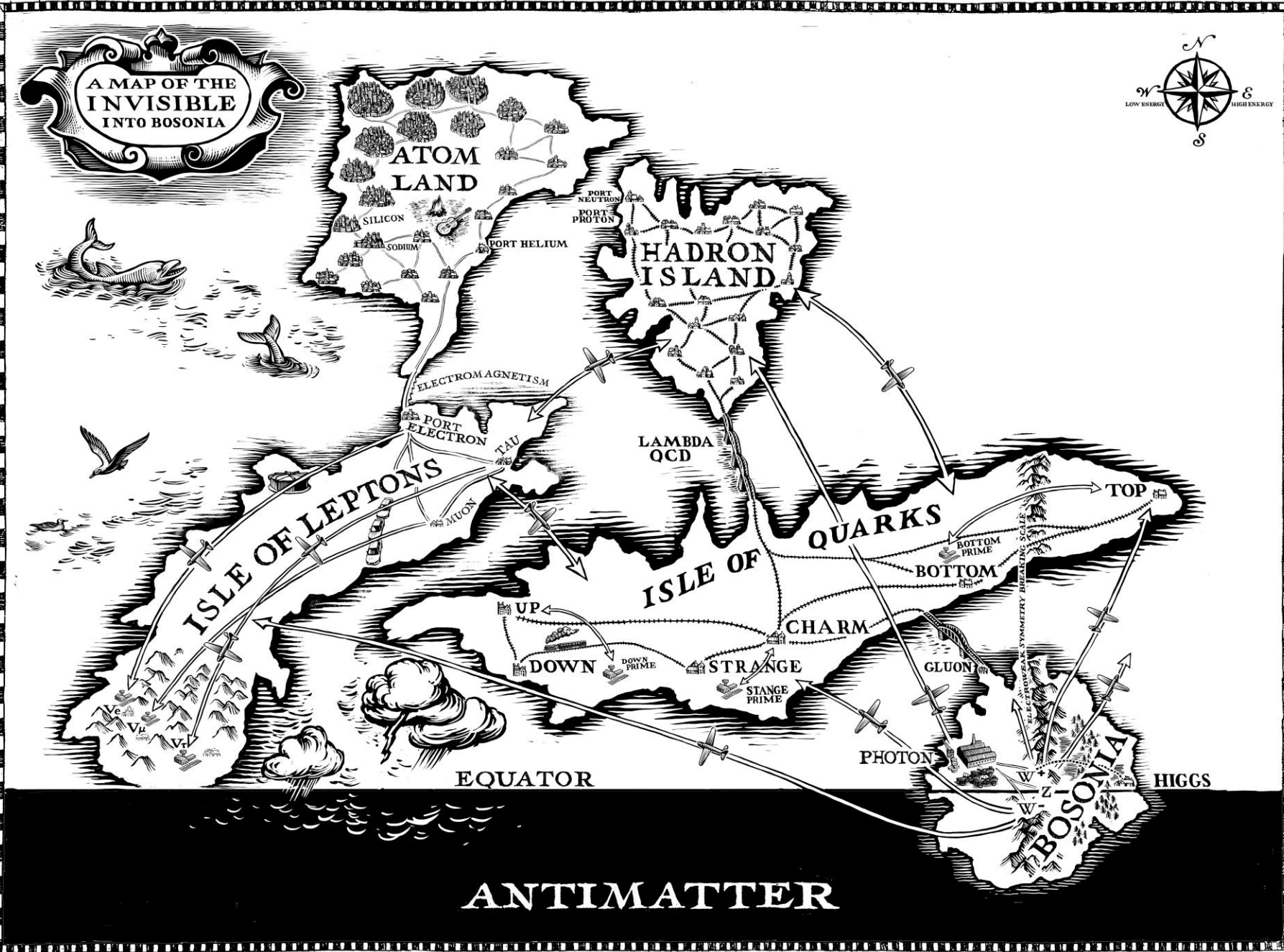


# Forces



# Leptons

**A MAP OF THE  
INVISIBLE  
INTO BOSONIA**

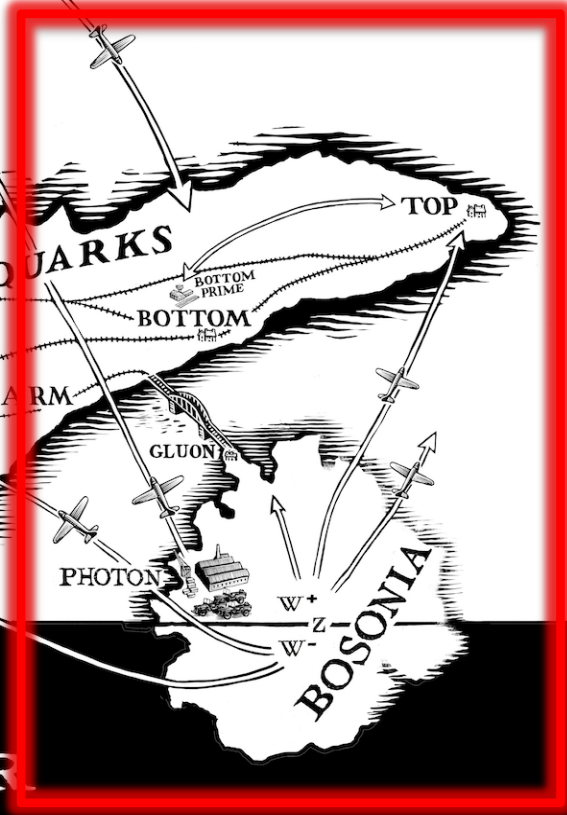
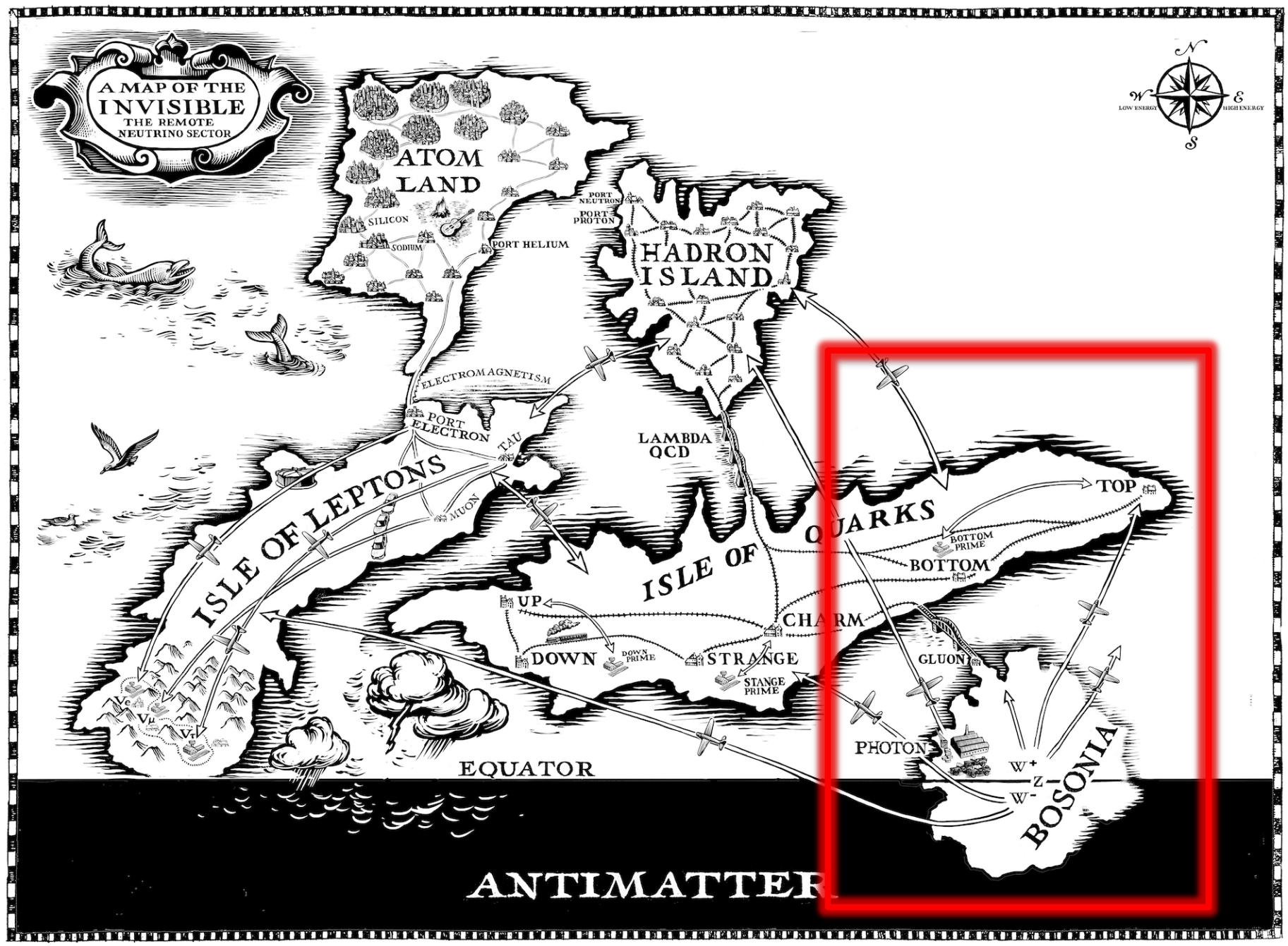






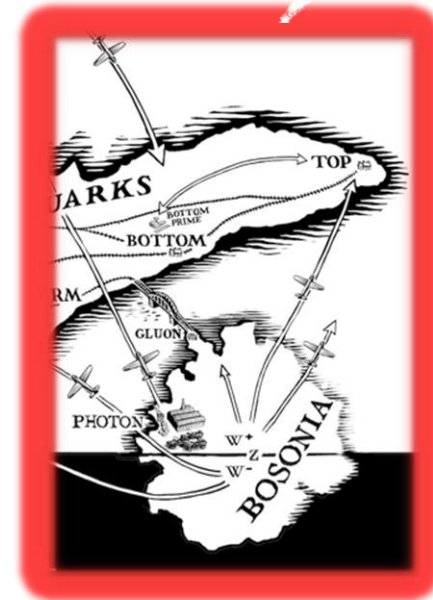
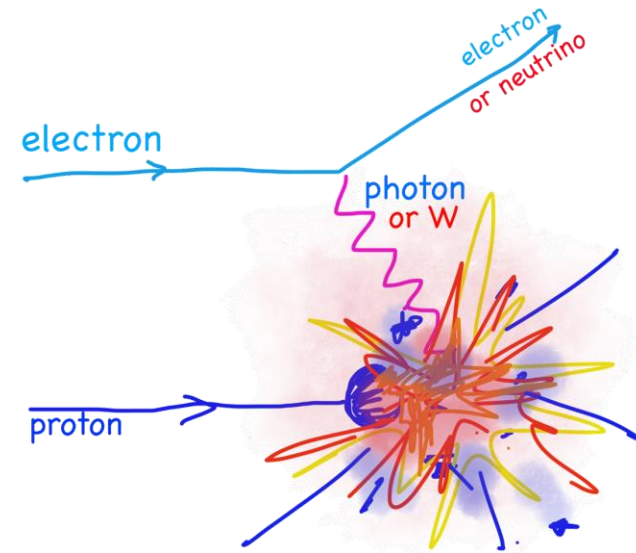
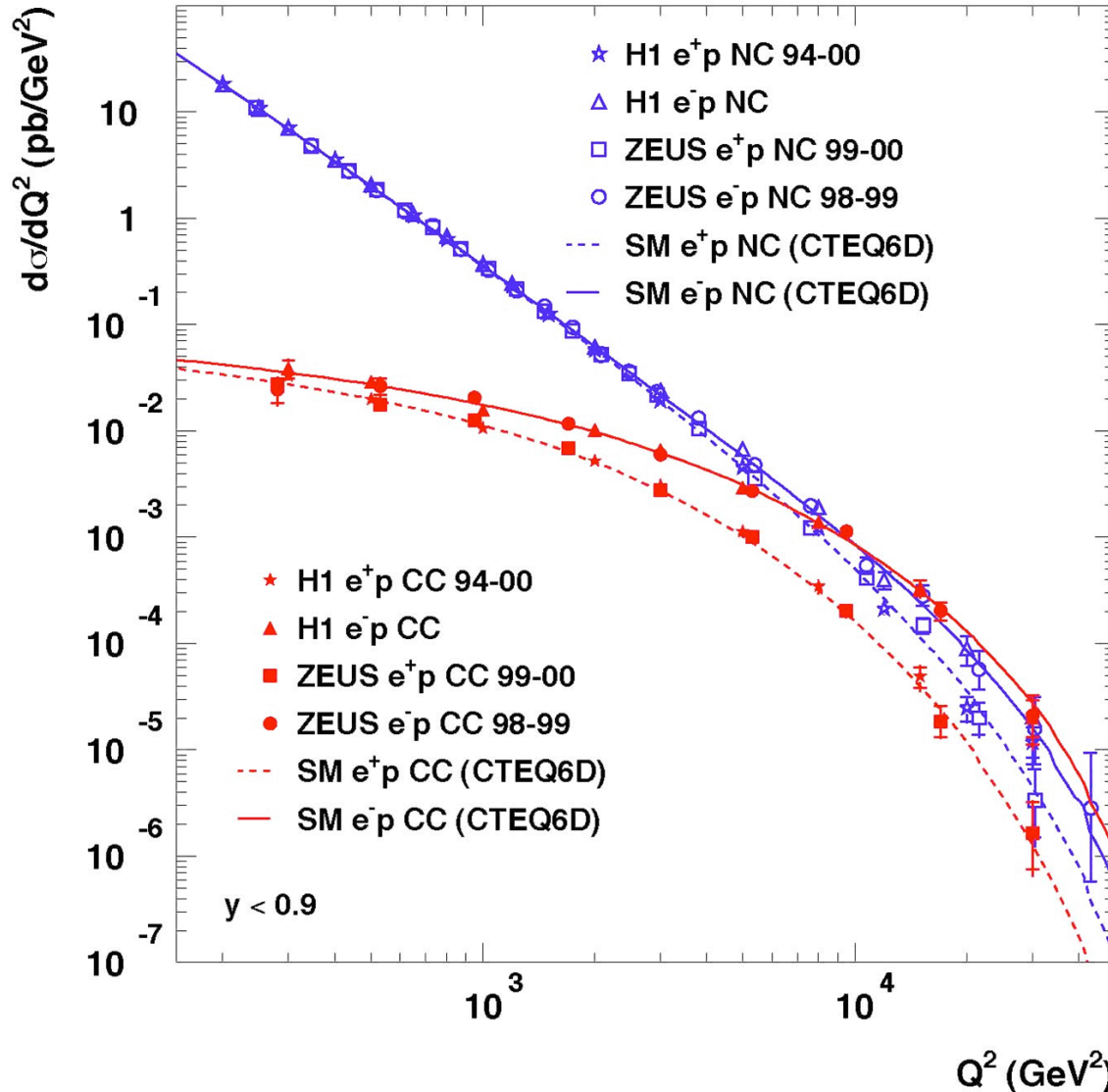


A MAP OF THE INVISIBLE  
THE REMOTE NEUTRINO SECTOR

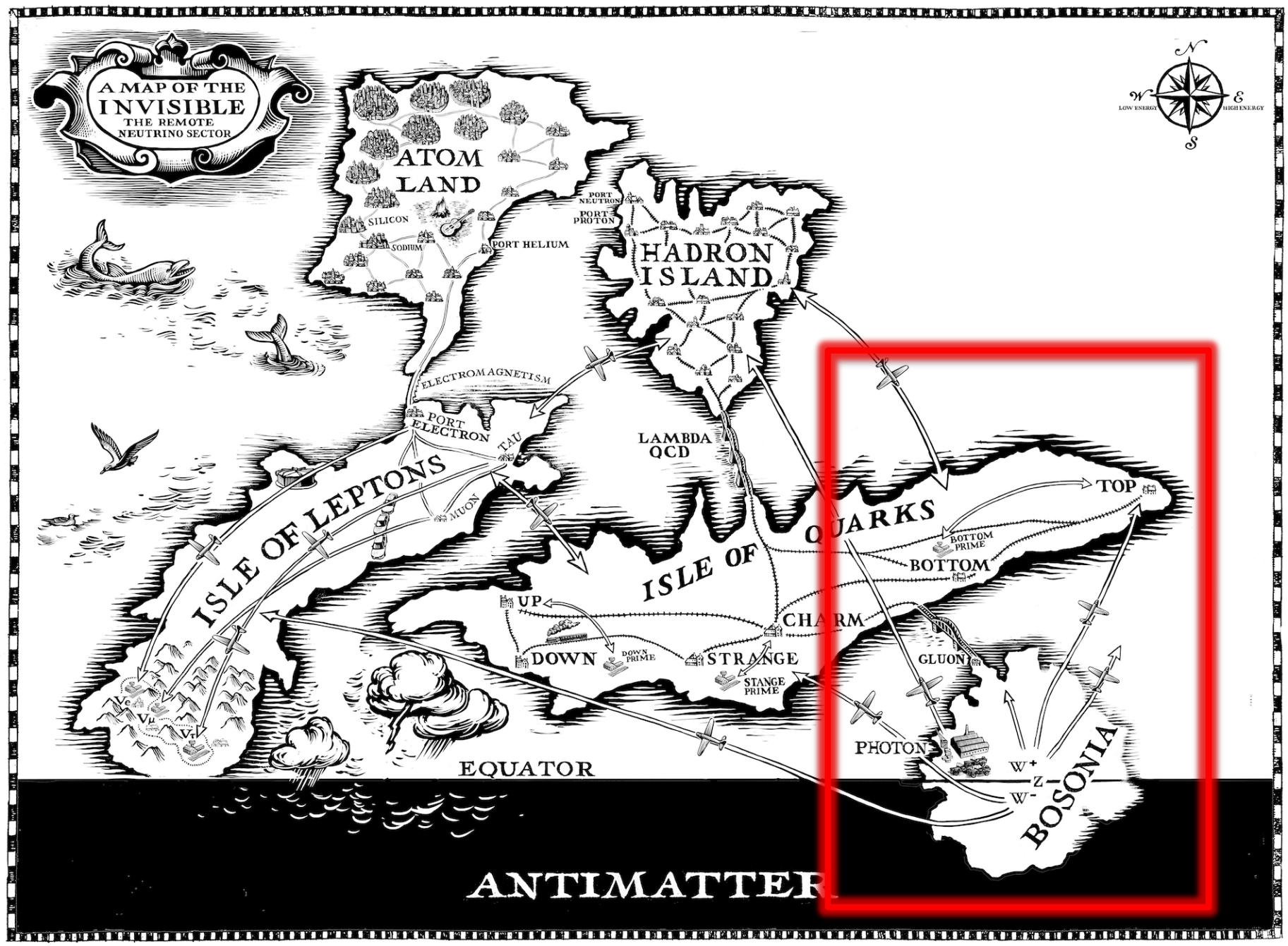




# HERA

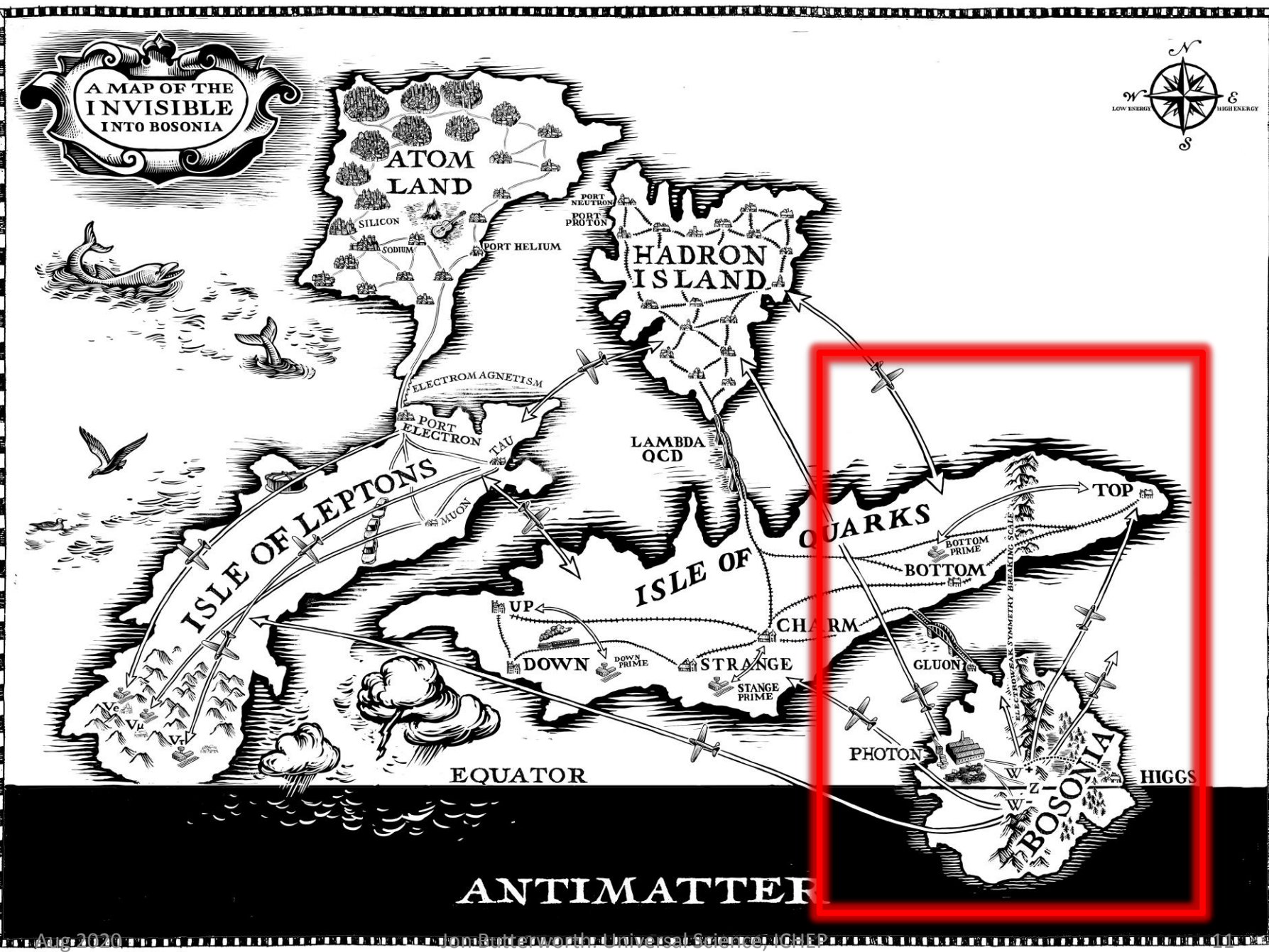


A MAP OF THE INVISIBLE  
THE REMOTE NEUTRINO SECTOR





**A MAP OF THE  
INVISIBLE  
INTO BOSONIA**



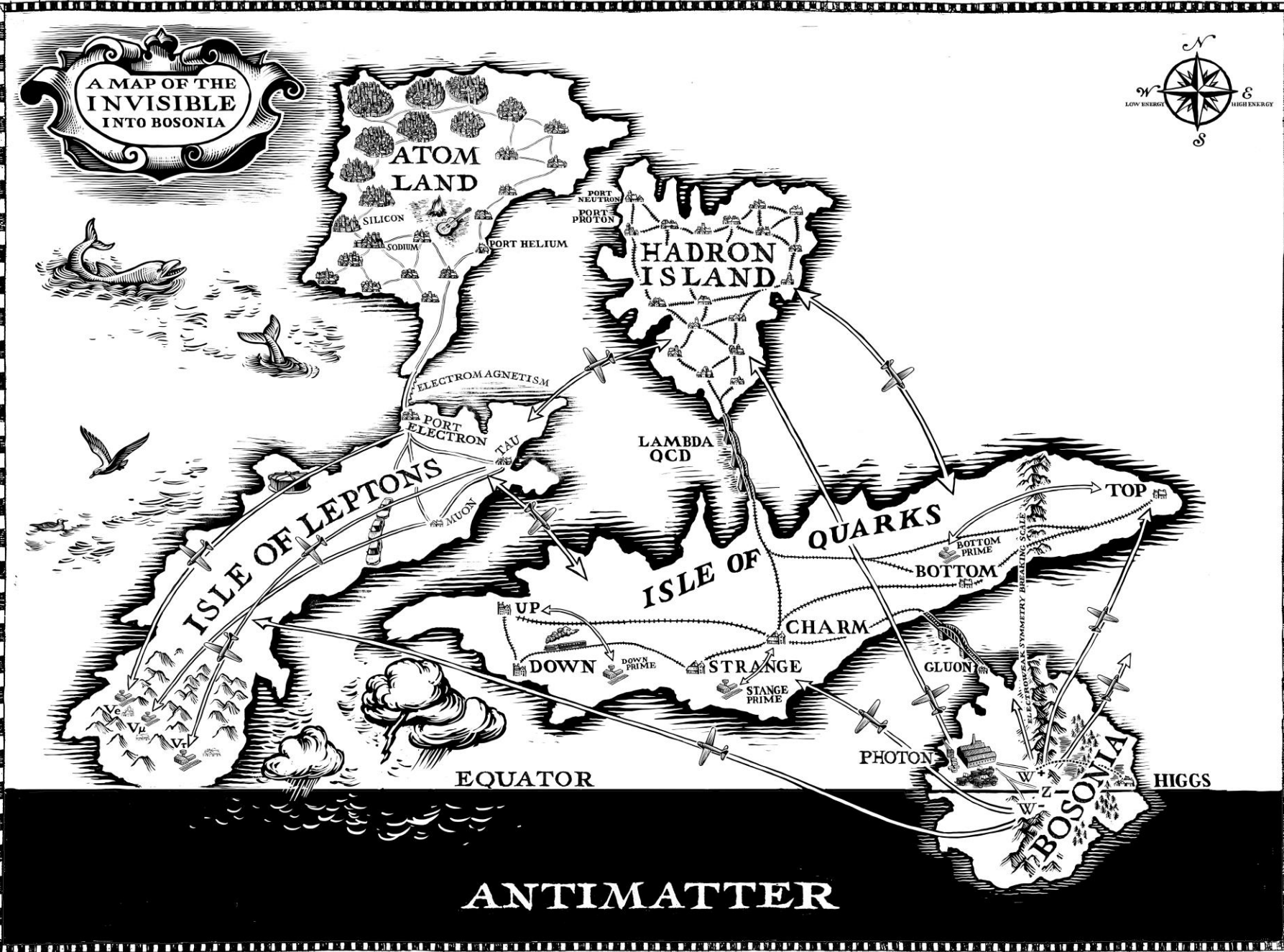


**A MAP OF THE  
INVISIBLE  
INTO BOSONIA**



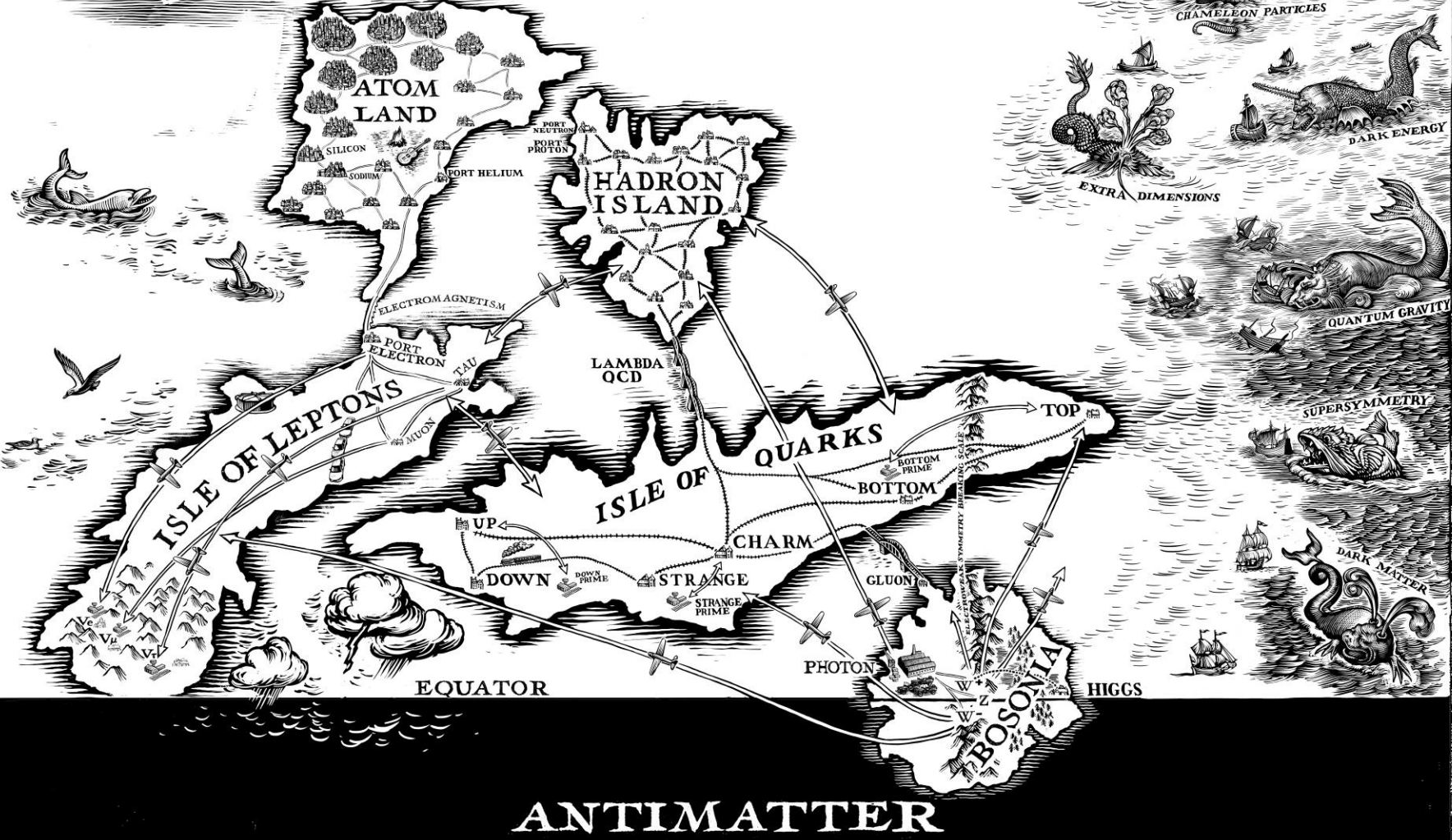


**A MAP OF THE  
INVISIBLE  
INTO BOSONIA**



**ANTIMATTER**

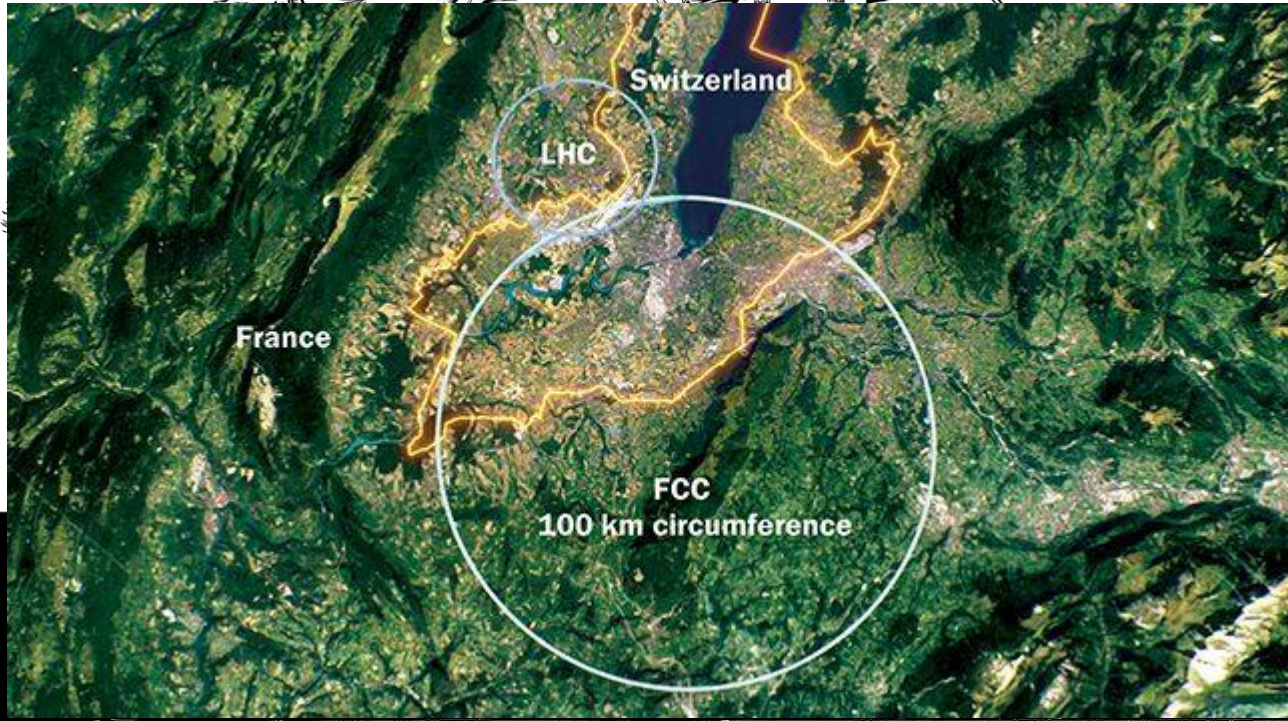
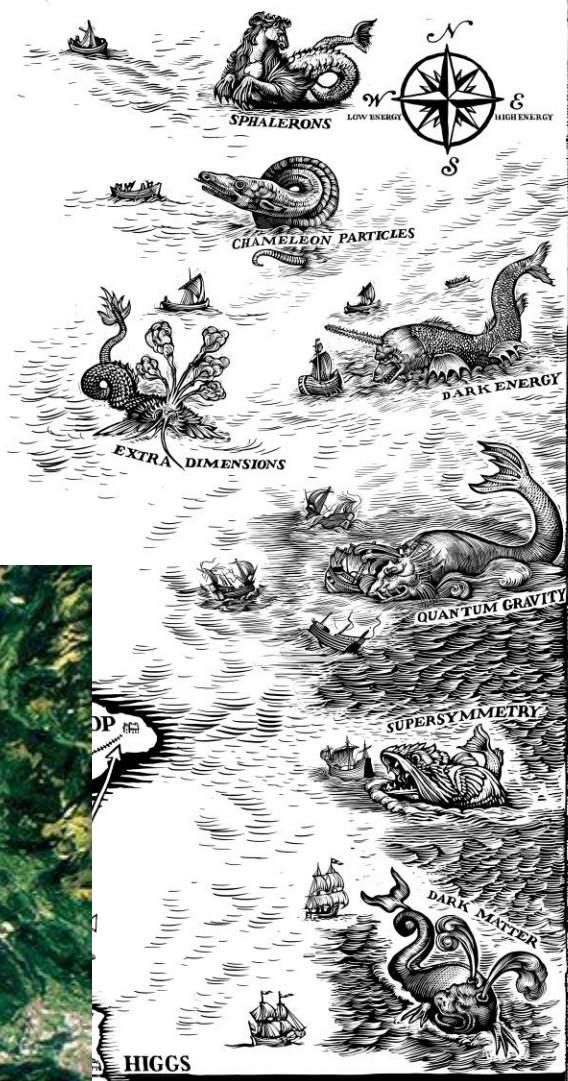
**A MAP OF THE  
INVISIBLE  
FAR EAST**



**ANTIMATTER**

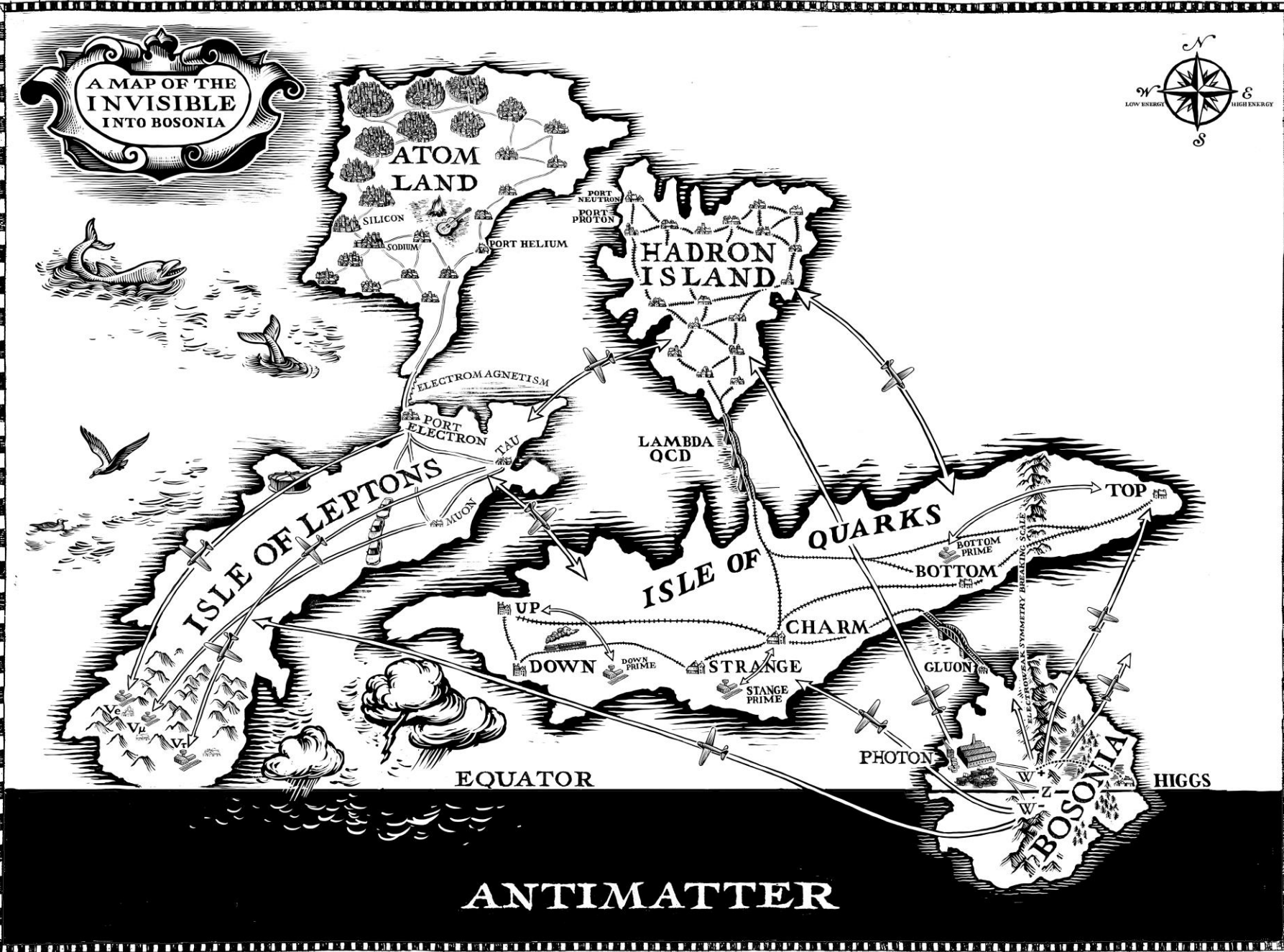


# A MAP OF THE INVISIBLE FAR EAST





**A MAP OF THE  
INVISIBLE  
INTO BOSONIA**



**ANTIMATTER**



**A MAP OF THE  
INVISIBLE  
INTO BOSONIA**

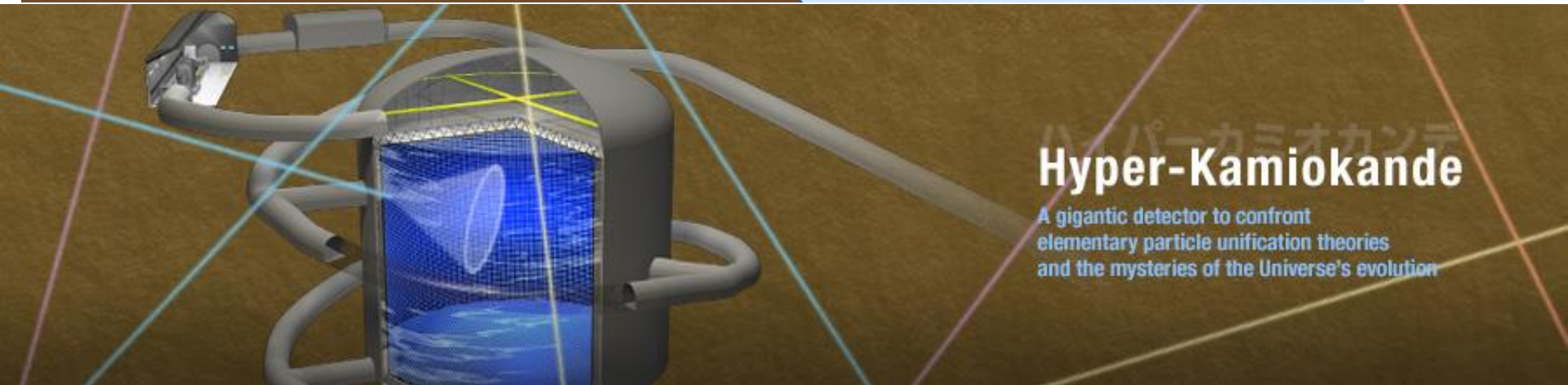


**ANTIMATTER**

# Deep Underground Neutrino Experiment

**Sanford Underground Research Facility**  
Lead, South Dakota

**Fermi National Accelerator Laboratory**  
Batavia, Illinois





CERN Council Open Symposium on the Update of

# European Strategy for Particle Physics

13-16 May 2019 - Granada, Spain



# Snowmass2021

WELCOME PAGE

ANNOUNCEMENTS

SNOWMASS CALENDAR

ETHICS GUIDELINES

## Organization

SNOWMASS ADVISORY GROUP

SNOWMASS STEERING GROUP

FRONTIER CONVENERS

APS DPF SNOWMASS PAGE

SNOWMASS EARLY CAREER

## Snowmass Frontiers

ENERGY FRONTIER

NEUTRINO PHYSICS FRONTIER

RARE PROCESSES AND PRECISION

COSMIC FRONTIER

THEORY FRONTIER

ACCELERATOR FRONTIER

INSTRUMENTATION FRONTIER

+Table of Contents

## Welcome to Snowmass 2021

The Particle Physics Community Planning Exercise (a.k.a. “Snowmass”) is organized by the Division of Particles and Fields (DPF) of the American Physical Society. Snowmass is a scientific study. It provides an opportunity for the entire particle physics community to come together to identify and document a scientific vision for the future of particle physics in the U.S. and its international partners. The P5 (Particle Physics Project Prioritization Panel) will take the scientific input from Snowmass and develop a strategic plan for U.S. particle physics that can be executed over a 10 year timescale, in the context of a 20-year global vision for the field.

We aim for everyone’s voice to be heard. Your contributions and participation are critical for the success of Snowmass and they will naturally occur as part of one or more working groups directed by the conveners. There will be various Town Hall meetings for us to communicate with you and to receive your feedback. You are also welcome to provide input and suggestions on the Slack channel (<https://snowmass2021.slack.com/>). This Snowmass wiki provides news and announcements and has pages dedicated to each frontier. If you are an early career scientist, we encourage you to join the “Snowmass Young” mailing list ([snowmass-young@fnal.gov](mailto:snowmass-young@fnal.gov)) by emailing to [listserv@listserv.fnal.gov](mailto:listserv@listserv.fnal.gov) with the body of the message “Subscribe snowmass-young YOUR NAME”. Agendas and presentations of all Snowmass-related meetings are available via [this Snowmass Indico link](#).

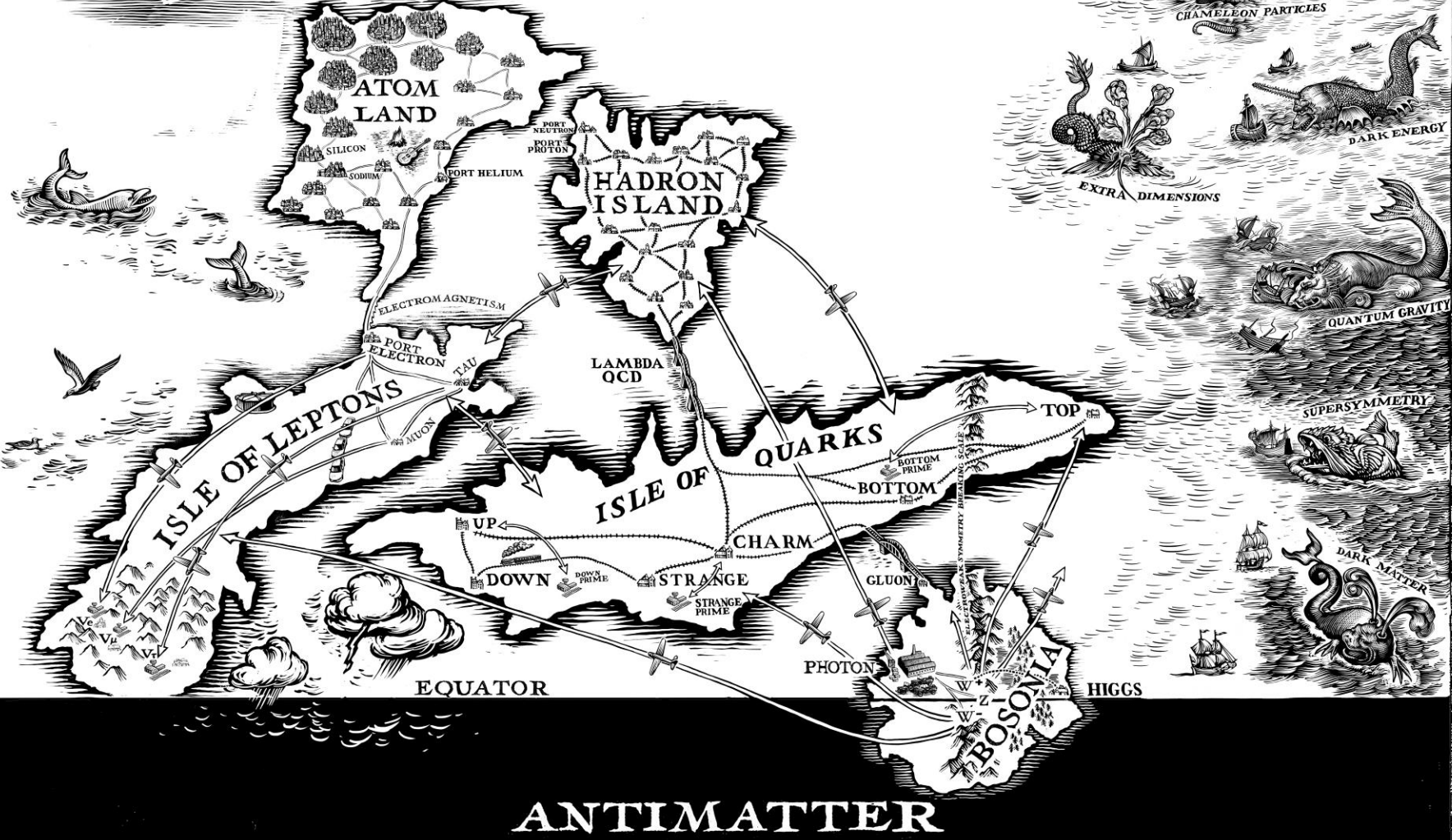
Sincerely,

Young-Kee Kim (DPF Chair), Tao Han (DPF Chair-Elect), Joel Butler (DPF Vice-Chair), Priscilla Cushman (DPF Past Chair)

Glennys Farrar (DAP Rep), Gabriela Gonzales (DGRAV Rep), Yury Kolomensky (DNP Rep), Sergei Nagaitsev (DPB Rep)



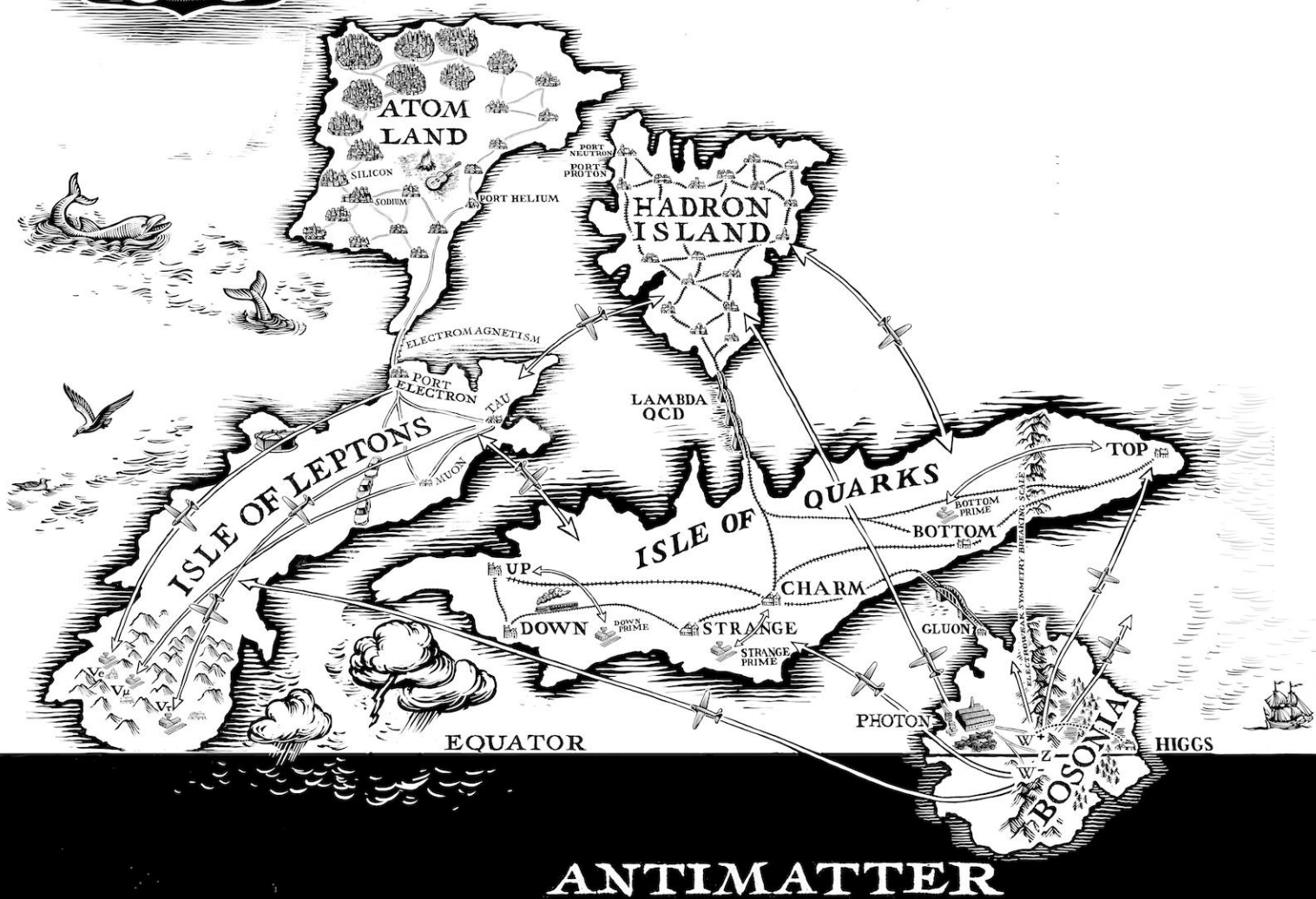
**A MAP OF THE  
INVISIBLE  
FAR EAST**



**ANTIMATTER**

A MAP OF THE  
INVISIBLE  
FAR EAST

# Or Is the Standard Model Isolated?



A MAP OF THE  
INVISIBLE  
FAR EAST

# Or Is the Standard Model Isolated?



Maps drawn by Chris Wormell, from "A Map of the Invisible / Atom Land by JMB