LEMON

Leptoquark Experiment of Moon Origin (New)

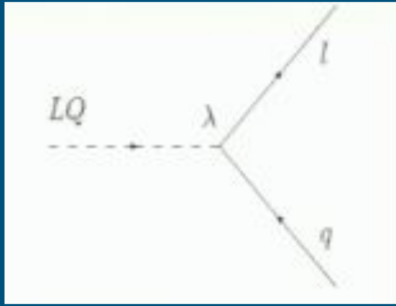
Properties of the leptoquark

Why are we searching for leptoquarks?

LQ's have gained more attention recently, as they could explain lepton universality violation observed at LHCb, Babar and Belle. (Wong et al, 2019)

- Leptoquarks are heavier than all known elementary particles.
- Similarly to other elementary particles they have very short lifetime and aren't present in ordinary matter.
- Due to their mass and the fact that they carry colour they are thought to mimic the creation of massive quarks.
- They also must interact with gluons (interacting with the strong nuclear force) showing they are suitable to try and produce in hadron colliders.

They decay into a quark and lepton or antilepton conserving the baryon number of the collision.

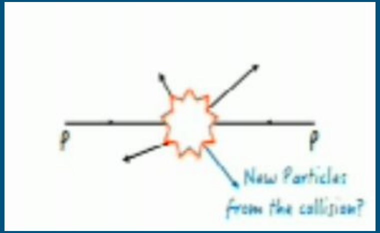


source : wikipedia, (franco,2018) https://en.wikipedia.org/wiki/Leptoquark ,https://en.wikipedia.org/wiki/Yukawa_interaction https://cds.cern.ch/record/2623680?ln=en

Leptoquark (LQ) detection

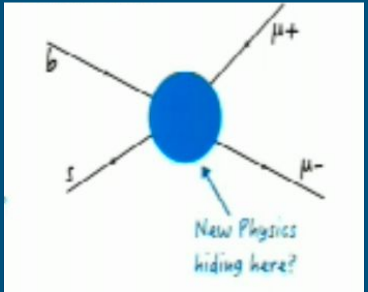
There are Two ways of Searching for Leptoquarks:

Directly



Two protons are collided and due to a higher energy being reached a new particle comes out product.

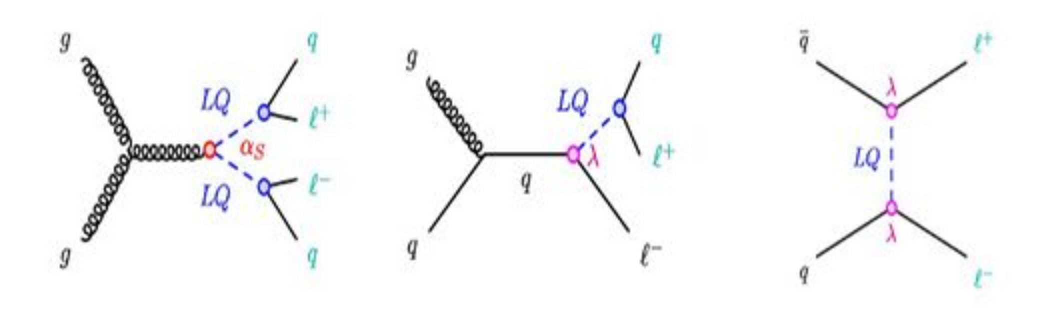
Indirectly



New physics occurring in an area that we can not observe.

Current insufficiency of ATLAS

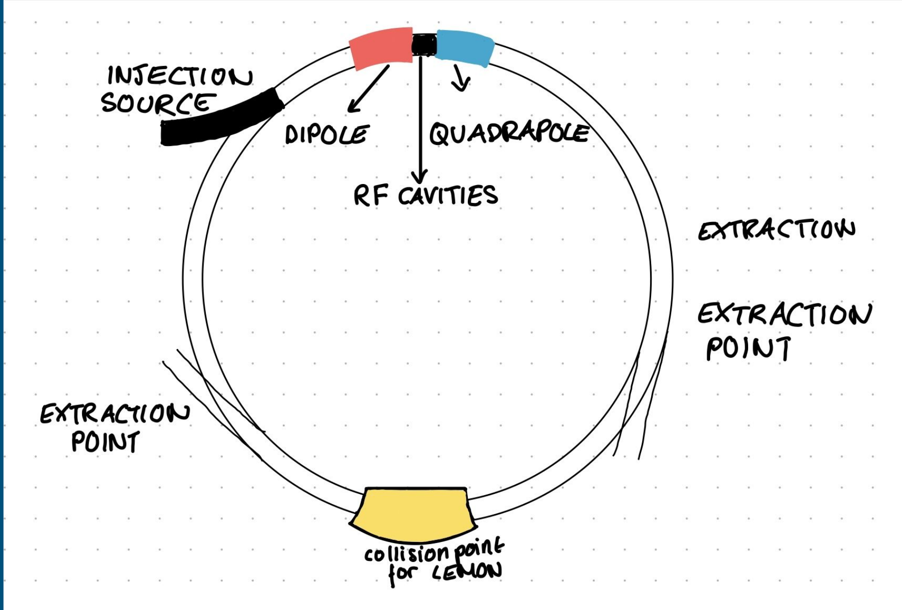
Leptoquarks would have to be high-mass particles because they have not already been found, in order to advance, a higher energy collider is needed.



The current focus is on the 3rd generation, including cross-generational decays. The potential for reinterpretations of Higgs boson results is highlighted. Search results are largely statistically limited, thus more sensitivity is expected with new data. There is a large potential in flavour physics for collaborations of phenomenologists and experimentalists.

Source : Searches for Leptoquarks with the ATLAS Detector (Sopczak, 2021)

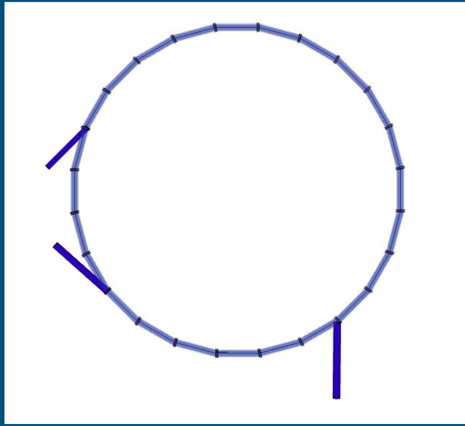
MILC:



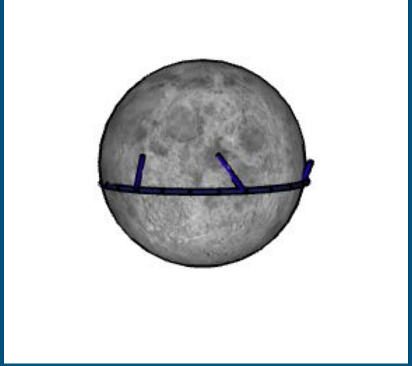
Moon Ingrained Large Collider

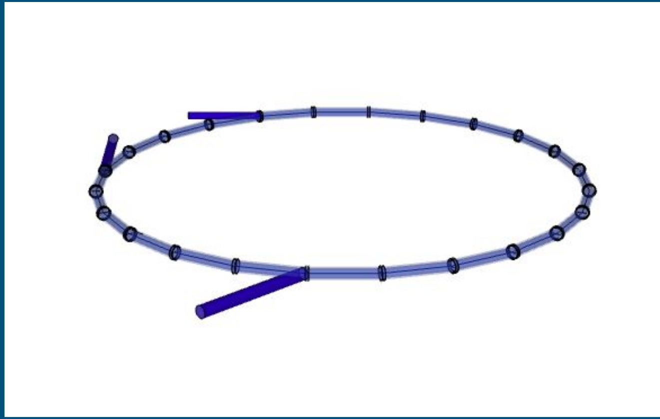
A large colliding measuring the circumference of the moon (10,000km long)

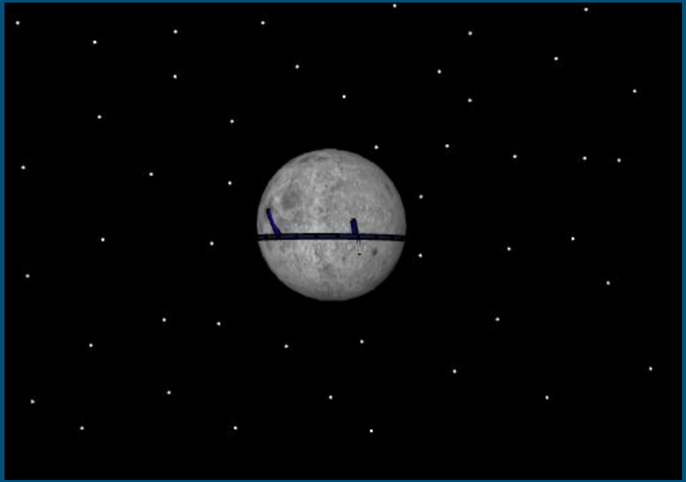
- Scaled version of LHC
- Improvement due to larger radius



Moon Ingrained Hadron Collider
3D view







Credit to 3D MasTer and 3D sketcher for components of the models

LHC	FCC	LEMON/MILC
27km	100km	10 000 km
13.1 TeV	100 TeV	13 800 TeV

$$KE = m_0c^2\left[\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}-1\right]$$

The LEMON Detector

Electromagnetic Calorimeters

Hadron Calorimeters

Tracking chamber

Muon tracker

Closest to the beam line is the inner tracking detector surrounded by a solenoid magnet with a homogeneous field of 2 T. Next are the electromagnetic and hadronic calorimeters that are used for particle shower reconstruction and energy measurement. Outside the calorimeters is the muon spectrometer with a toroidal magnet. All of these subsystems are used in the LQ searches.

https://cds.cern.ch/record/2681533/files/ATL-PHYS-PROC-2019-060.pdf

https://indico.cern.ch/event/719627/attachments/1651152/2654647/LHCSeminar_29_05_018_FR.pdf

https://www.livescience.com/63800-lhc-narrows-range-for-leptoquark-particles.html

https://cds.cern.ch/record/2623680?ln=en

https://arxiv.org/pdf/2107.10094.pdf