UNIVERSITY OF Southampton

elusives

Horizon 2020

Dark Matter and Flavour Anomalies

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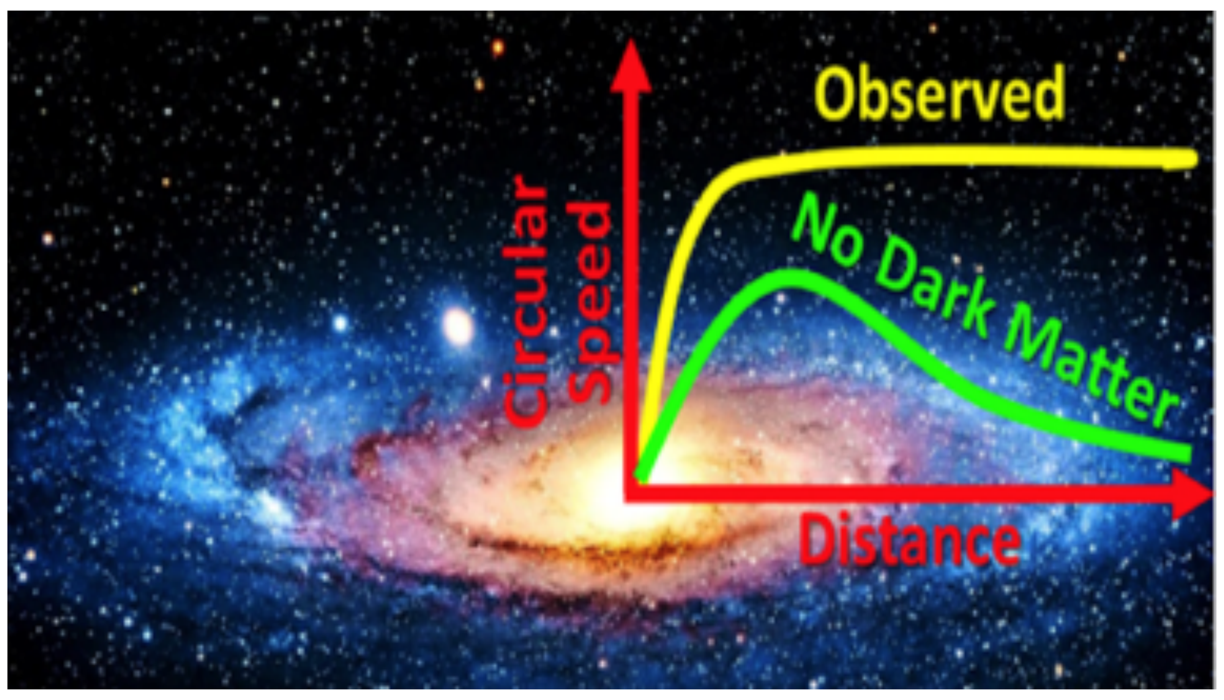
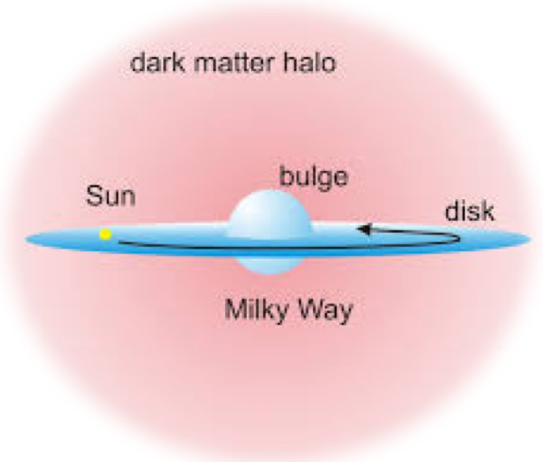
1. Dark Matter

- Newton's Law $G\frac{mM}{r^2} = ma$ tell us that the rotation velocity of the gas and stars around the galaxy should diminish the further away from the galactic nucleus they are.



[M. Cappellari and the Sloan Digital Sky Survey]

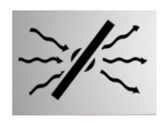
- What we observe: the speed of rotation does not change!



[S. Hossenfelder]

- The galaxies aren't as small as they appear to be but rather are surrounded by an immense halo that is nine time more massive than the galaxies themselves.

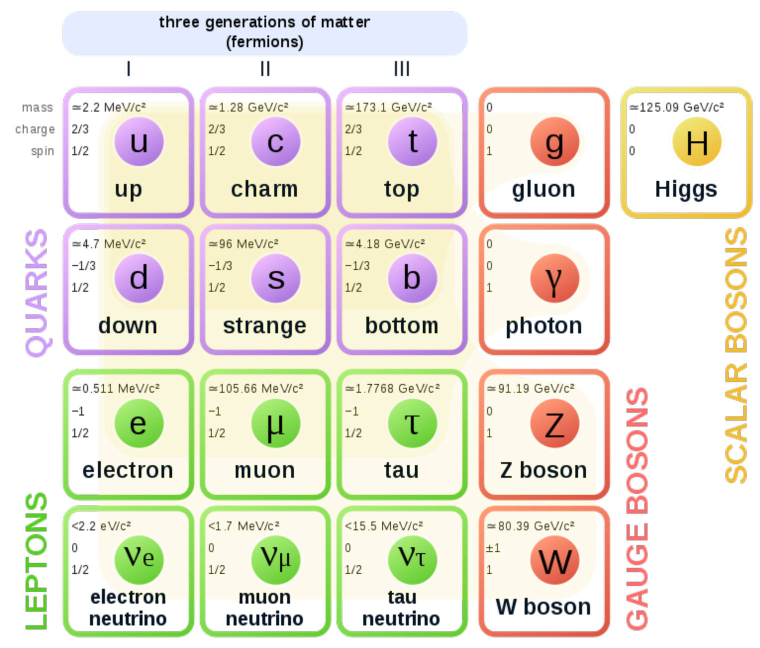
Characteristics

- **Neutral:** It does not interact with electromagnetic waves, neither absorbs or emit them → **"Dark"**. 
- **Stable:** It does not decay to other particles over time.
- **Cold:** It is not relativistic. It does not move near the speed of light.

Who are the suspects?

- The Standard Model is the theory which presents us with the list of most elementary particles of the universe.
- Neither ordinary matter nor neutrinos, which could be the main candidates, fit the profile.

Standard Model of Elementary Particles

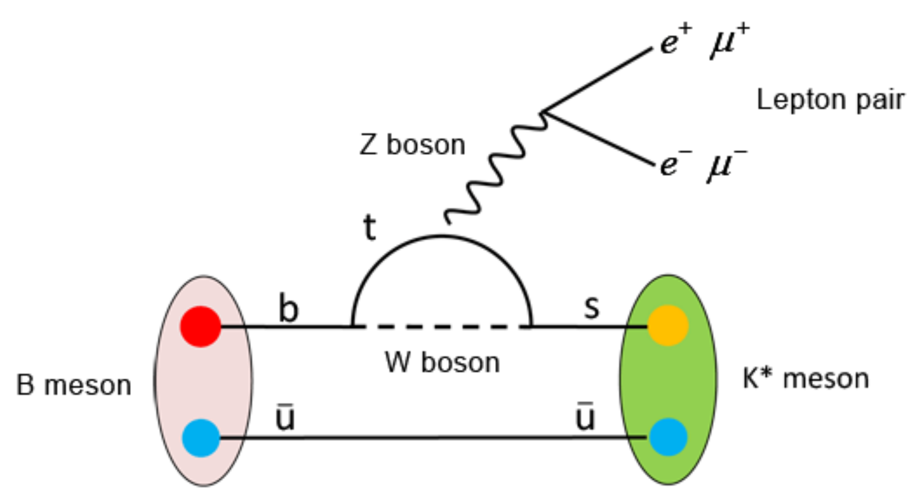


[Particle Data Group]

- In order to understand dark matter, we need some kind of new physics, the physics that goes beyond the Standard Model.
- We look for exotic new aspirants to Dark Matter.

2. Flavour Anomalies

- The LHC experiment finds intriguing anomalies in the way some particles decay.
- In particular, it has reported a number of deviations in B mesons decaying to $K^{(*)}$ mesons plus a pair of electrons or muons.



[Belle experiment-KEK]

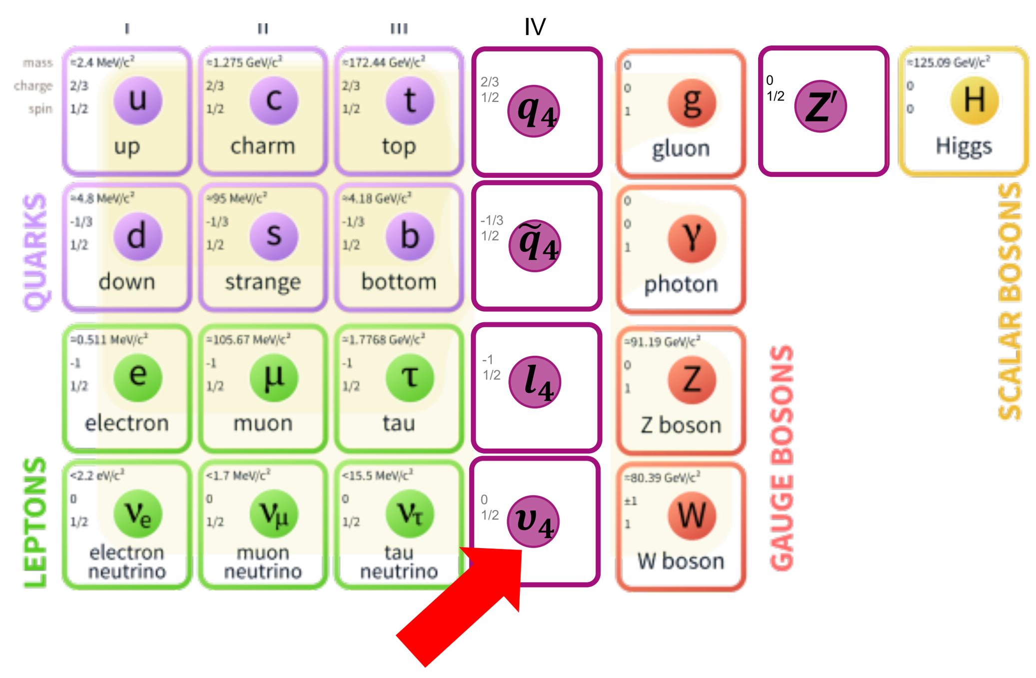
- The Standard Model predicts that electron and muons should be produced with the same probability. LHC finds instead that the decays involving muons occur less often.
- The discrepancies between data and the Standard Model predictions are a clear hint for…

New physics Beyond the Standard Model!

- These data can be well fit when considering Z' models.

3. My Research

- We consider a model in which, in addition to the Standard Model, we add a fourth family of fermions and a dark $U(1)'$ gauge symmetry, giving rise to a new Z' boson.



DARK MATTER CANDIDATE!

- We look for the parameter space where this explanation is consistent with existing experimental constraints from dark matter direct and indirect detection, LHC searches, and precision measurements of flavour mixing and neutrino processes.

300 GeV $\lesssim M_{Z'} \lesssim$ 1 TeV $m_{\nu_4} \gtrsim$ 1 TeV

References

A. Falkowski, S. F. King, E. Perdomo and M. Pierre. *Flavourful Z' portal for vector-like neutrino Dark Matter and $R_{K^{(*)}}$. JHEP 1808 (2018) 061,* [arXiv: 1803.04430].

Acknowledgments

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