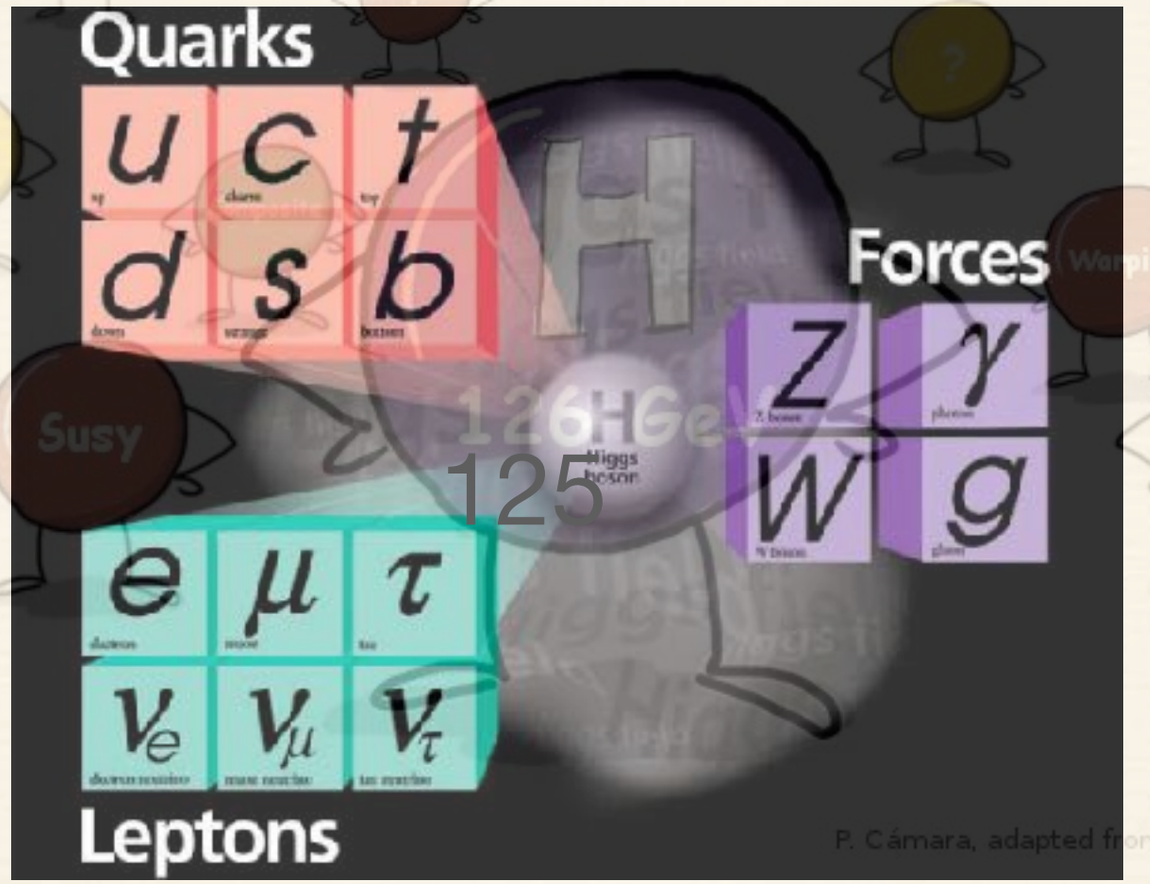
Particle Physics

Pôle théorie IJClab
Journée des Nouveaux Entrants
27/03/2024



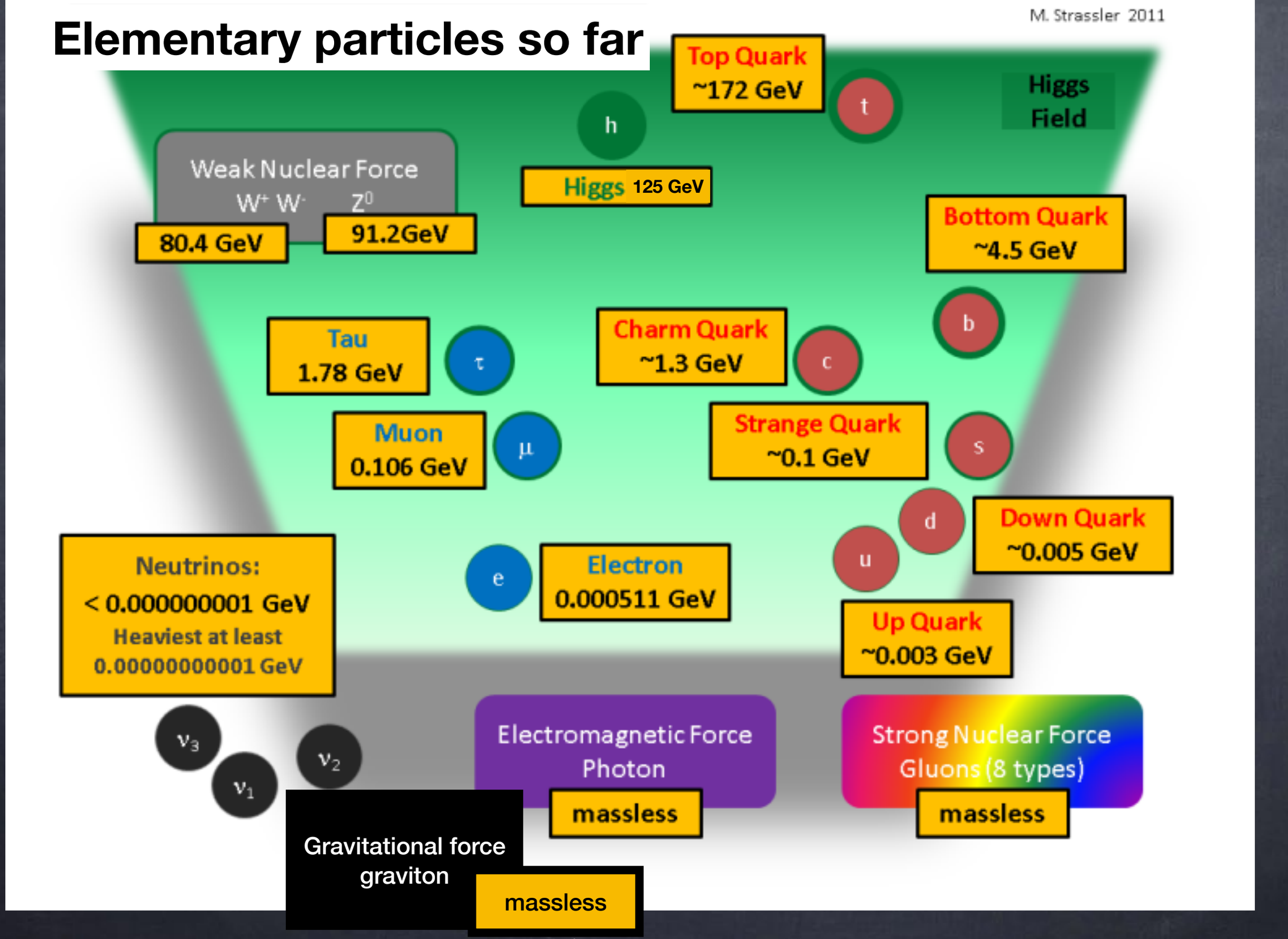
IJClab
Irène Joliot-Curie

Goal of Particle Physics

To Answer the Ultimate Question of Life, The Universe, and Everything

- ~~D'où venons-nous ?~~
- ~~Que sommes-nous ?~~
- ~~Où allons-nous ?~~
- **What is the world made of**
- **What forces keep it together**

Elementary particles so far



Borrowed from Matt Strassler's blog: http://profmattstrassler.com/

Recent and ancient history

Particle	Year	Collider	Energy	Place	Spin
Higgs boson	2012	LHC	8 TeV	Europe	0
Top quark	1995	Tevatron	1.8 TeV	USA	1/2
W/Z bosons	1984	SppS	630 GeV	Europe	1
Gluon	1979	PETRA	38 GeV	Europe	1
Bottom quark	1977	E288	20 GeV	USA	1/2
Tau lepton	1975	SPEAR	3 GeV	USA	1/2
Charm quark	1974	SLAC/BNL	3 GeV	USA	1/2
…					
Photon	1905	Einstein's brain	/	Europe	0
Electron	1897	Cathode rays @Cambridge	~1 MeV	UK	1/2

Position within Theory Pole

QCD

Flavor Physics

Nuclear Physics

BSM /Higgs

Statistical Physics

Mathematical Physics

Gravitation/ Cosmology

BSM/Higgs

Asmaa ABADA (Pr)

Salvador ROSAURO-ALCARAZ

Yann MAMBRINI (DR)

Jong-Hyun YOON

Simon CLERY

Mathieu GROSS

Gregory MOREAU (MdC)

Adam FALKOWSKI (DR)

Panagiotis MARINELLIS

Edoardo ALVIANI

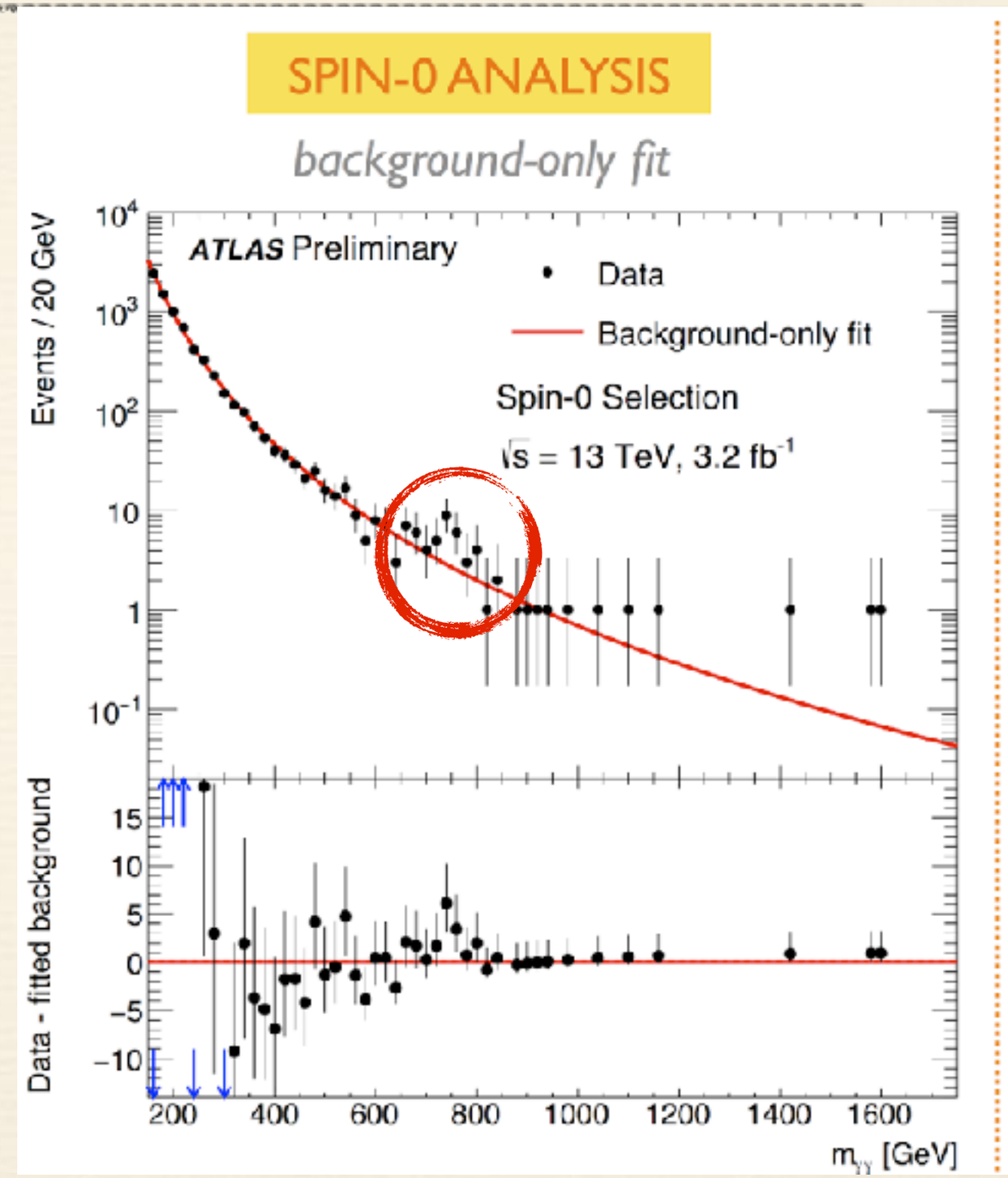
Ulrich ELLWANGER (Em)

BSM/Higgs

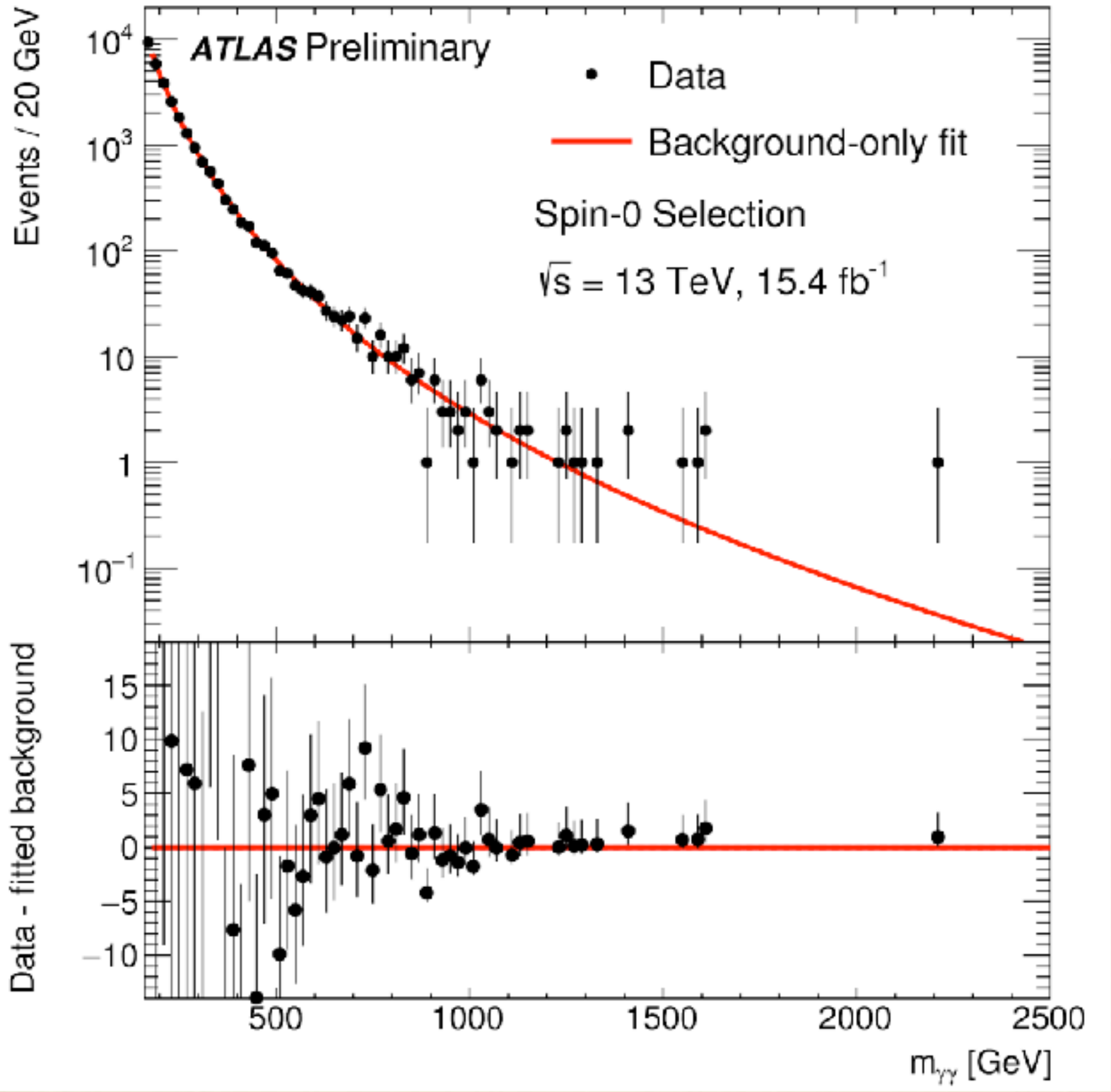
BSM group asks a lot of question

- Are there new particles beyond those of the Standard Model
- How is electroweak symmetry broken
- How do neutrinos get their mass
- What was happening in the first seconds of the universe
- What is the nature of dark matter
- What caused matter-antimatter asymmetry
- Are there extra dimensions of spacetime

BSM - Nobel Prize 2017



BSM/Higgs

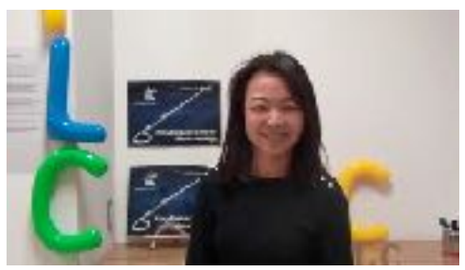

ATLAS Preliminary
Data
Background-only fit
Spin-0 Selection
√s = 13 TeV, 15.4 fb-1
Events / 20 GeV
Data - fitted background
mγγ [GeV]

Flavor Physics

Damir BEČIREVIĆ (DR)

Teseo SAN JOSE PÉREZ

Benoît BLOSSIER (DR)



Tejhas KAPOOR

Emi KOU (DR)

Méril REBOUD (CR)

Ioannis PLAKIAS

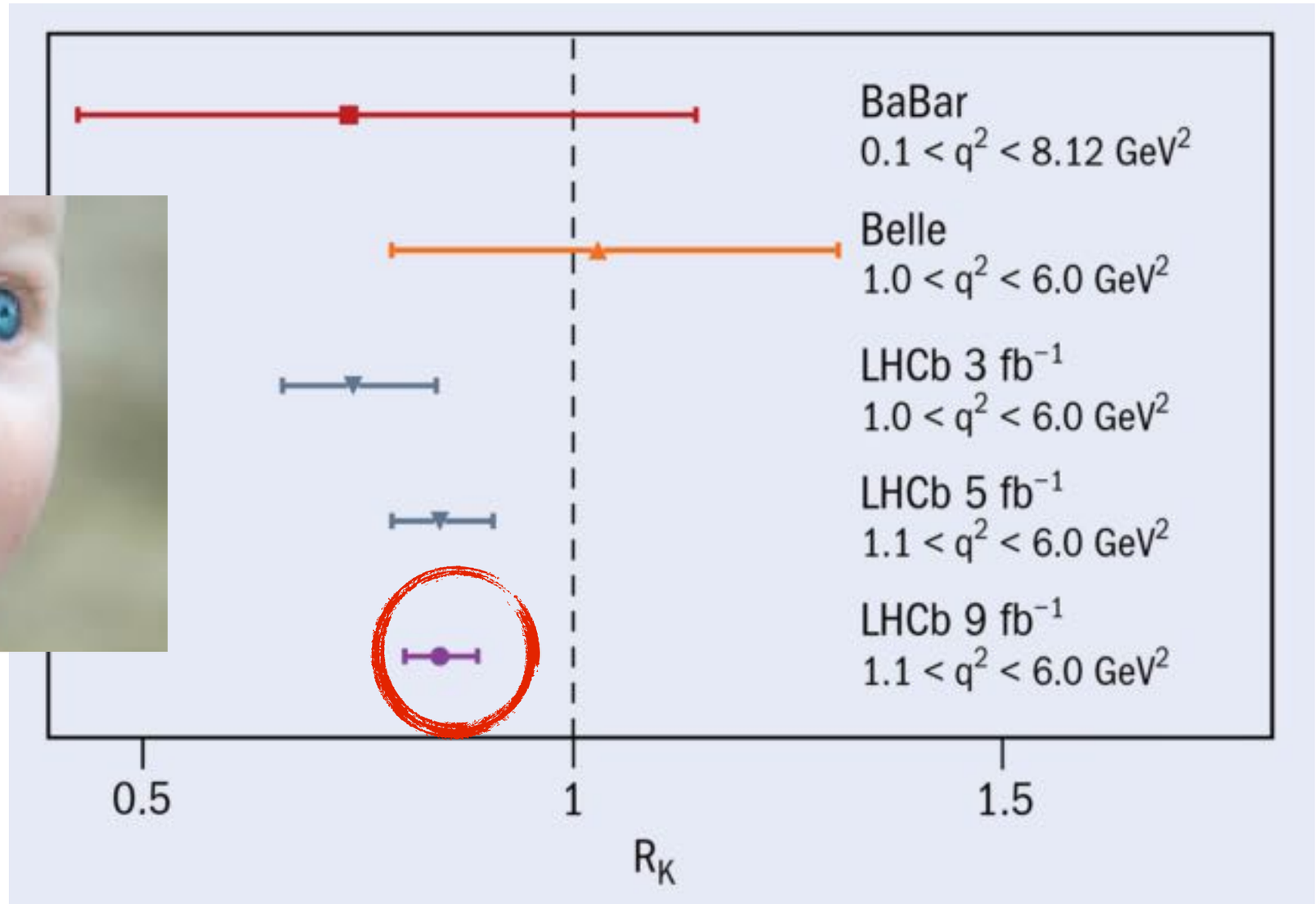
Olcyr SUMENSARI (CR)

Alain LE YAOUANC (Em)

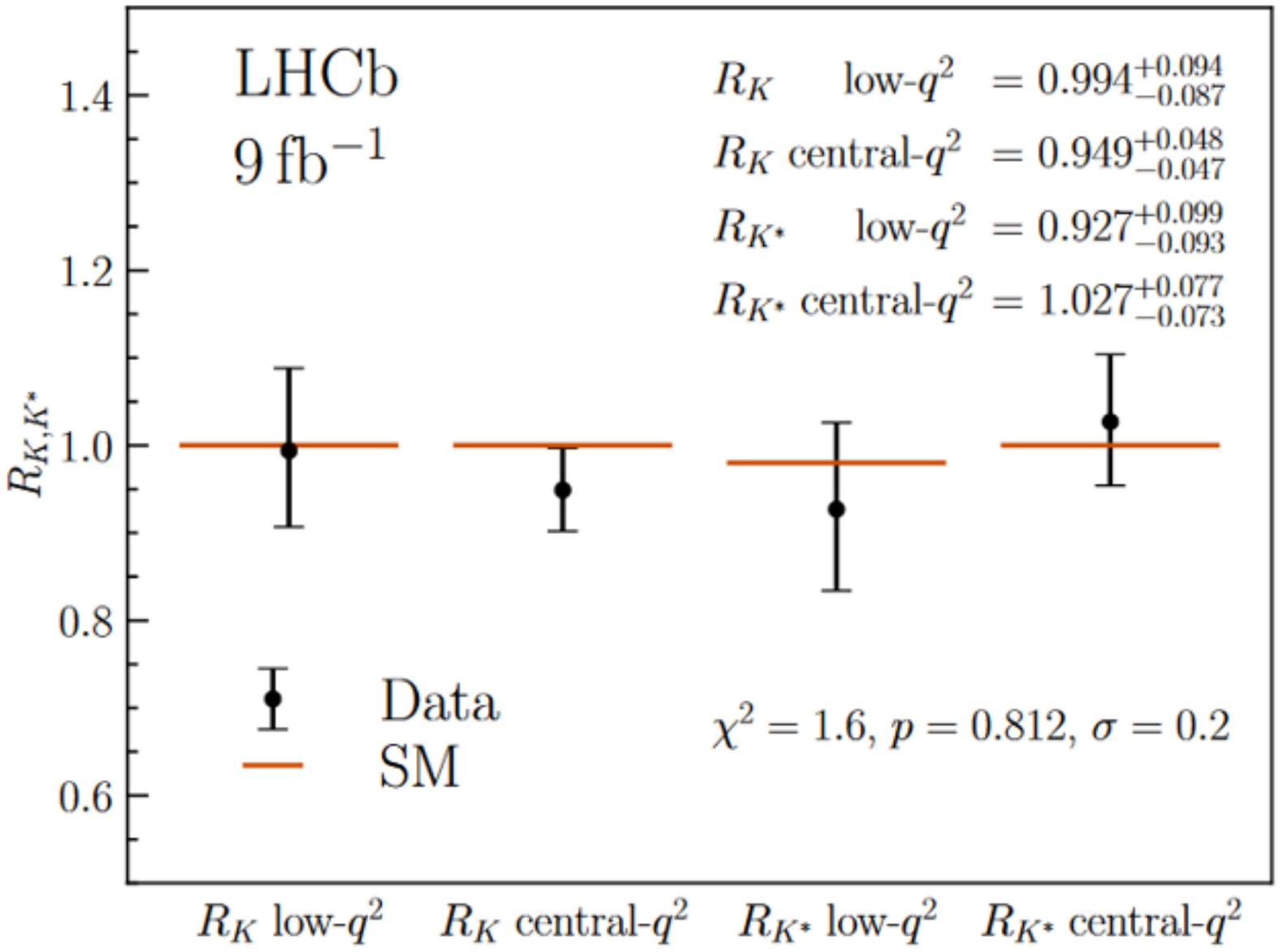
Flavor Physics

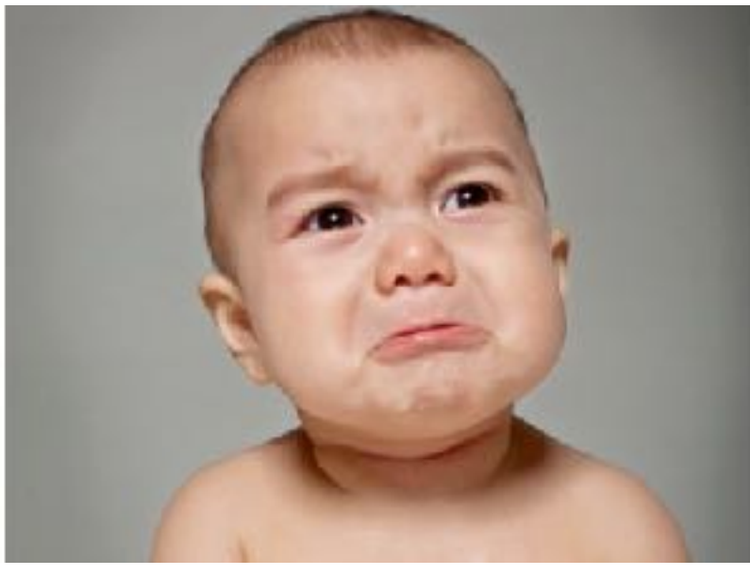
- Flavor physics group is straddling the line between beyond and within the Standard Model
- It is focused on the dynamics and decays of composite particles containing a heavy quark (b or c)
- On one hand, these allow us to better understand the Standard Model, in particular the action of the strong force
- On the other hand, flavor transitions are naturally suppressed in the Standard Model and therefore they are very sensitive to physics beyond the standard model

Flavor Physics - Nobel Prize 2021



Flavor Physics





QCD

Christopher FLETT

Maxim NEFEDOV

Jean-Philippe LANSBERG (DR)

Kate LYNCH

Yelyzaveta YEDELKINA

Allencris JOHN RUBESH RAJAN

Melih OZCELIK (CR)

Michael FUCILLA

Saad NABEEBACCUS

Joseph YARWICK

Samuel WALLON (Pr)

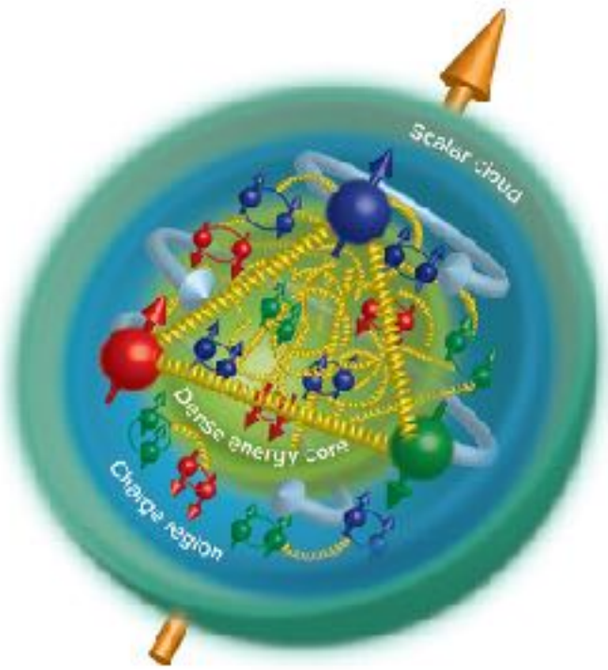
Véronique BERNARD (Em)

Michel FONTANNAZ (Em)

Bachir MOUSSALLAM (Em)

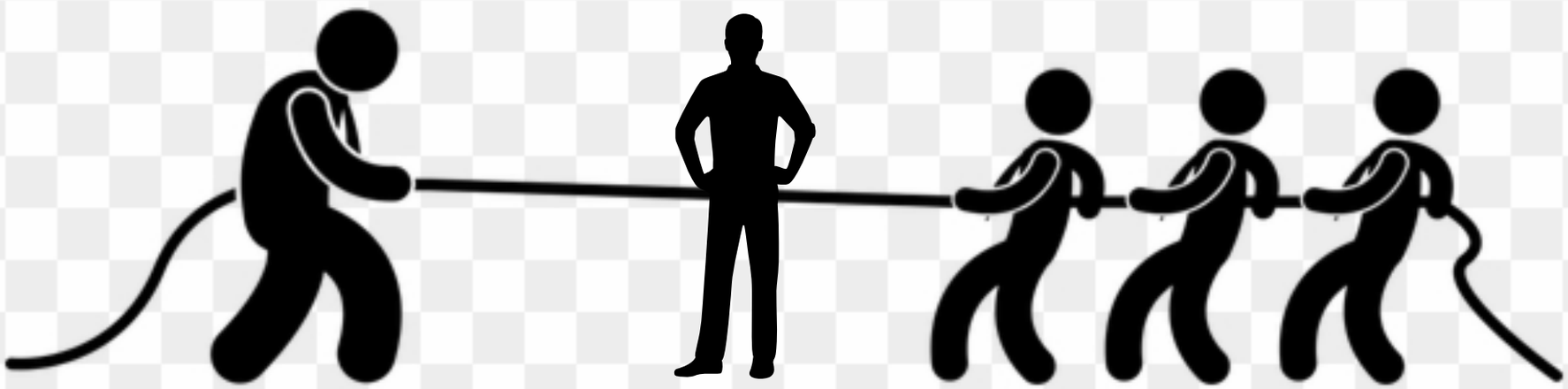
Hagop SAZDJIAN (Em)

QCD



- QCD group attempts to better understand the consequence of the Standard Model strong dynamics in various systems
- Many conceptual and quantitative problems remains to be solved
- Examples of problems tackled in JLab include quarkonium production, (generalized) parton distribution functions, small x physics, non-perturbative power corrections

Conclusions



SM Flavor BSM