(not so new)
BSM Theory in 10 Minutes

New Perspectives 2019

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Why Beyond Standard Model?

- Naturalness, Higgs mass unstable under quantum correction
- Dark Matter $\Omega_{non-baryonic\,matter}\,h^2 = 0.1186 \pm 0.0020$
- Baryogenesis, why matter > antimatter?
- Neutrinos have masses (Cf. Kevin Kelly's "Neutrino Theory in 10 Minutes")

Solutions to Naturalness

- Supersymmetry, boson becomes “chiral”
- Composite higgs, NGB of Spontaneous Symmetry Breaking (like pions in QCD)
- Extra dimension, e.g. RS: $d^2s = a(y)^2\eta_{\mu\nu}dx^\mu dx^\nu + dy^2,\ a(y) = e^{-ky}$
- Neutral Naturalness (colorless top partner) e.g. the “Twin” series of models
- Relaxions

Particle DM Candidates

- must be stable on cosmological time scales
- must have very little interaction with SM
- must have the right relic abundance: $\Omega_{DM}h^2 = 0.1186 \pm 0.0020$
- WIMP, GeV~ TeV, e.g. LSP from SUSY
- Axion-like Particles, non-thermally produced, very light
- sterile neutrino, asymmetric DM, SIMP, and many many more…

Sakharov's Conditions for Baryogenesis

- B violation
- Loss of Thermal Equilibrium $X \rightleftharpoons Y + B \quad m_X \gg m_Y \sim m_B$
- C violation $\frac{dB}{dt} \propto \Gamma(X \to YB) - \Gamma(\bar{X} \to \bar{Y}\bar{B})$
- CP violation $C : q_L \to \bar{q}_L \quad CP : q_L \to \bar{q}_R$

$$\Gamma(X \to Yq) = \Gamma(X \to Yq_L) + \Gamma(X \to Yq_R) \overset{CP}{=} \Gamma(\bar{X} \to \bar{Y}\bar{q}_R) + \Gamma(\bar{X} \to \bar{Y}\bar{q}_L) = \Gamma(\bar{X} \to \bar{Y}\bar{q})$$

Mechanism: Electroweak Baryogenesis, Leptogenesis

Why is SUSY popular?

- protects the higgs mass from quadratic divergences
- R-symmetry, provides a WIMP DM candidate
- extended Higgs sector, eg. NMSSM can address EWBG