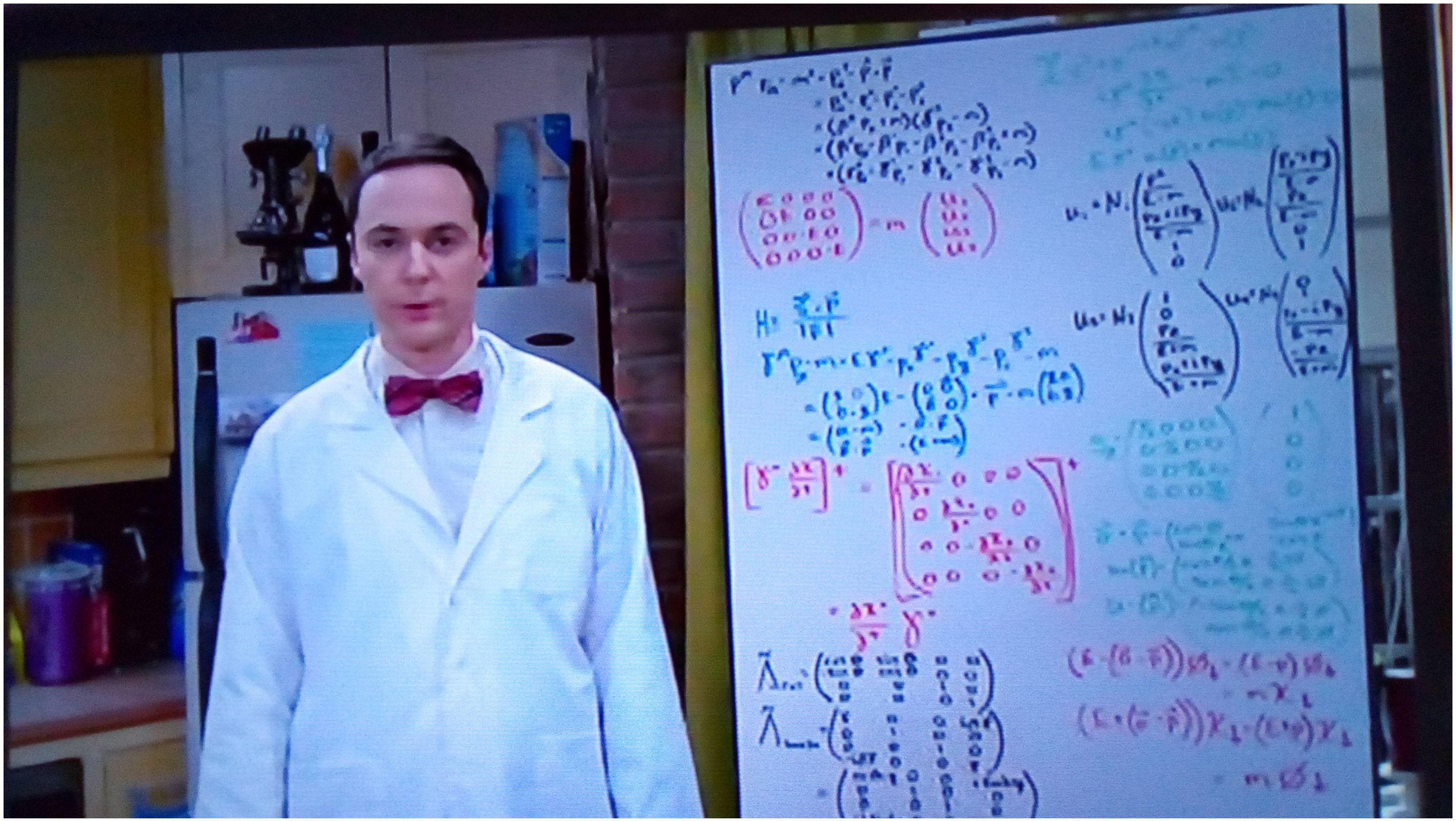
B2
Symmetry and Relativity
Lecture 17

Of what use is it?



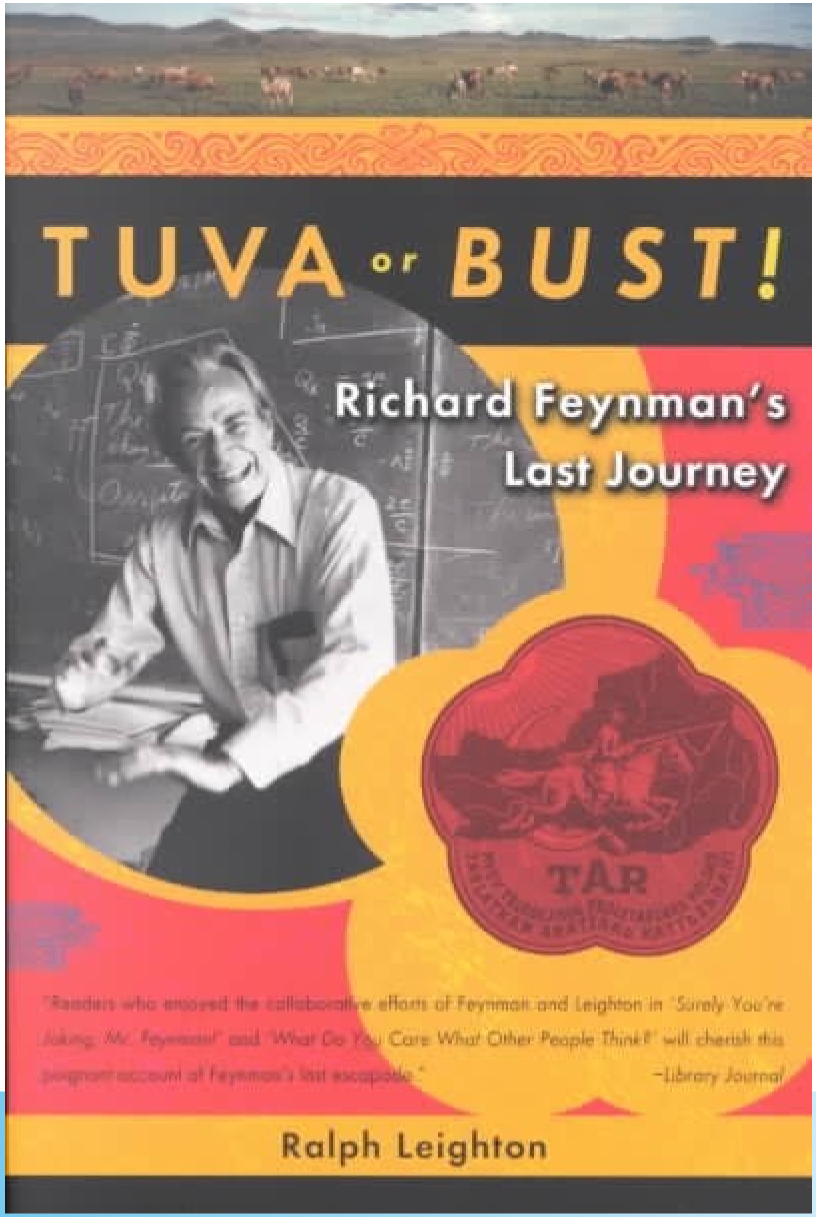
Physics etc

Fat Man & Little Boy (1989)

David Politzer

Nobel lecture (2004)

Other stuff


TUVA or BUST!
Richard Feynman's
Last Journey
TAR
"Readers who enjoyed the collaborative efforts of Feynman and Leighton in 'Surely You're Joking, Mr. Feynman!' and 'What Do You Care What Other People Think?' will cherish this poignant account of Feynman's last escapade."
—Library Journal
Ralph Leighton

Lagrangians in the wild

- Recipe for form-invariant equations of motion:
  - Form-invariant scalar Lagrangian (density)
  - Plug into form-invariant Euler-Lagrange

A lot of particle physics papers start off by specifying such a Lagrangian

2. Toy Model

2.1. Real Scalar Triplet

The possibility of extending the SM with a real $SU(2)_W$ triplet scalar has been extensively studied [21–30] since such extensions generally lead to suppressed contributions to electroweak precision observables (EWPO). The scalar Lagrangian for a toy model including all possible gauge invariant combinations of a Higgs doublet, H, and an $SU(2)_W$ triplet, Σ, given by

$$H = \begin{pmatrix} \phi^+ \\ \phi^0 \end{pmatrix}, \qquad \Sigma = \frac{1}{2}\begin{pmatrix} \eta^0 & \sqrt{2}\eta^+ \\ \sqrt{2}\eta^- & -\eta^0 \end{pmatrix}, \tag{1}$$

can be written as

Kinetic energies

$$\mathcal{L}_{\text{scalar}} = (D_\mu H)^\dagger (D^\mu H) + Tr(D_\mu \Sigma)^\dagger (D^\mu \Sigma) - V(H,\Sigma), \tag{2}$$

where

$$V(H,\Sigma) = -\mu^2 H^\dagger H + \lambda_0 (H^\dagger H)^2 + \frac{1}{2} M_\Sigma^2 Tr[\Sigma^2] + \frac{b_4}{4} Tr[\Sigma^2]^2 + a_1 H^\dagger \Sigma H + \frac{a_2}{2} H^\dagger H Tr[\Sigma^2], \tag{3}$$

is the scalar potential [28, 29], and the covariant derivatives are the standard $SU(2)_W \times U(1)_Y$, as in the SM.

The scalar potential can be minimized along the directions of the neutral components of both H and Σ, leading to two conditions:

Higgs mass and self-interactions

New particle mass and self-interactions

Higgs+new particle interactions

EC Leskow, TAW Martin, A de la Puente, arXiv:1409.3579v2, 2 Oct 2014

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Symmetries!

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