2017 MITP Summer School Lectures -- Outline
SM, EWSB, Higgs
4x1.5h blackboard lectures
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1. Monday 07.08 9:00-10:30: **Dimensional analysis, EW theory and SM Higgs mechanism**
    0. Particle physics and dimensional analysis: natural units vs hbar dimension
    1. Beta decay & Fermi theory
    2. SU(2)xU(1) vs Georgi-Glashow
    3. pi -> e nu_e vs pi -> mu nu_mu and V-A structure of the weak interaction
    4. SM Higgs mechanism - W and Z masses
    5. SU(2)xU(1)->U(1)em, counting number of degrees of freedom
    6. rho parameter
    7. custodial symmetry
        SO(4)/SO(3)
        SO(4)~SU(2)xSU(2)
        rho=1
        W_L and Z_L as of SU(2)xSU(2)/SU(2), Sigma matrix, unitary gauge

2. Tuesday 08.08 11:00-12:30 : Goldstone equivalence theorem, WW scattering, Higgs unitarization
    1. h->WW - computation in the unitary gauge and using the Goldstone's
    2. t -> Wb - computation in the unitary gauge and using the Goldstone's
    3. validity of the Goldstone eq. theorem: m << E << 8 pi m/g
    4. expression of longitudinal polarization vector
    5. WW scattering in the unitary gauge: cancelation of the E^4 terms
    6. Higgs unitarization for WW->WW, WW->hh, WW-> ff
    7. Basic structures of Higgs couplings
    8. Higgs production/decay channels at the LHC
    9. remarks on the importance of h->gg and h->gam gam as test of naturalness
        Higgs low energy theorem
        remark on apparent (non-)decoupling

3. Wednesday 09.08 11:00-12:30: RG effects in Higgs potential, hierarchy problem
    1. triviality bound
    2. stability bound
    3. general discussion on the problem of quadratic divergences
    4. computation of the quadratically divergent diagrams
    5. Coleman-Weinberg potential
    6. solutions to the hierarchy problem: susy vs composite

4. Thursday 10.08 16:00-17:30: Higgs&BSM: effective theory approach
1. Higgs couplings modifications due to the (d_mu H^2)^2 operator
2. Universality of Higgs coupling deviations close to SM
3. Higgs primary operators
4. SILH basis and power counting (hbar dimensions again)
5. SO(5)/SO(4) composite Higgs models. Matching with EFT
6. Flat direction: top Yukawa - contact interactions to gluons/photons
   Higgs+jet boosted channel
   off-shell channel

Extra material (if time permits and/or strong interest):
0. GUT
1. Extra dimensions: large vs warped
2. Symmetry breaking by boundary conditions
3. AdS/CFT model building for pheno: Higgsless and composite Higgs
4. Higgs-cosmology interplay: relaxion model to solve the hierarchy problem
5. Finite temperature corrections, EW phase transition in the SM
6. HLET from alpha_s and alpha_em runnings
7. Non-interference theorems SM - BSM, helicity selection rules
8. Higgs portal models: power counting