Group Work Instruction

- First, please form a few groups from each of Yonsei / Saga Univ. Each group will be composed of about 3 or 4 students.
- Let me (fusayasu at cc.saga-u.ac.jp) know the group composition and your choice of problem by 13/Jan. (Wed.)
- Group work presentation: 21/Jan. 14:40 online.

Problem 1

HWs (P. Ko's lecture on EFT)

- $g \sim O(1)$ dimensionless constant, encoding microscopic physics for the radiative transitions (electric dipole,…)
- Now the new physics scale relevant to this case is $\Lambda \sim a_0^{-1}$, since we are ignoring fine structure now
- HW 1: Show that $\Gamma(H(2P) \to H(1S) + \gamma) = \left(\frac{4}{3} g^2\right) \alpha a_0^2 \omega^3$
- QM textbook : $\Gamma(H(2P) \to H(1S) + \gamma) = \frac{2^{17}}{3^{11}} \alpha a_0^2 \omega^3$
- $g = 0.74$: is really ~O(1)

- HW 2: Show that $H(2S) \to H(1S) + \gamma$ is forbidden by showing that there are no effective operators allowed by symmetries. What is the allowed decay mode of $H(2S)$ into $H(1S)$ with emitting photons ?
- HW 3: In Nature, one observes $\rho^0(770) \to \pi^+\pi^-$, but not $\rho^0 \to \pi^0\pi^0$. Can you explain why this is the case ? Which symmetry forbids the latter decay mode ? [This is a kind of theorem similar to Landau-Yang theorem: Spin-1 particle can not decay into a pair of identical scalar particles]
- HW4: Prove Landau-Yang theorem [a spin-1 particle can not decay into a pair of photons]. How about the case a colored spin-1 particle decays into a pair of gluons in QCD ?

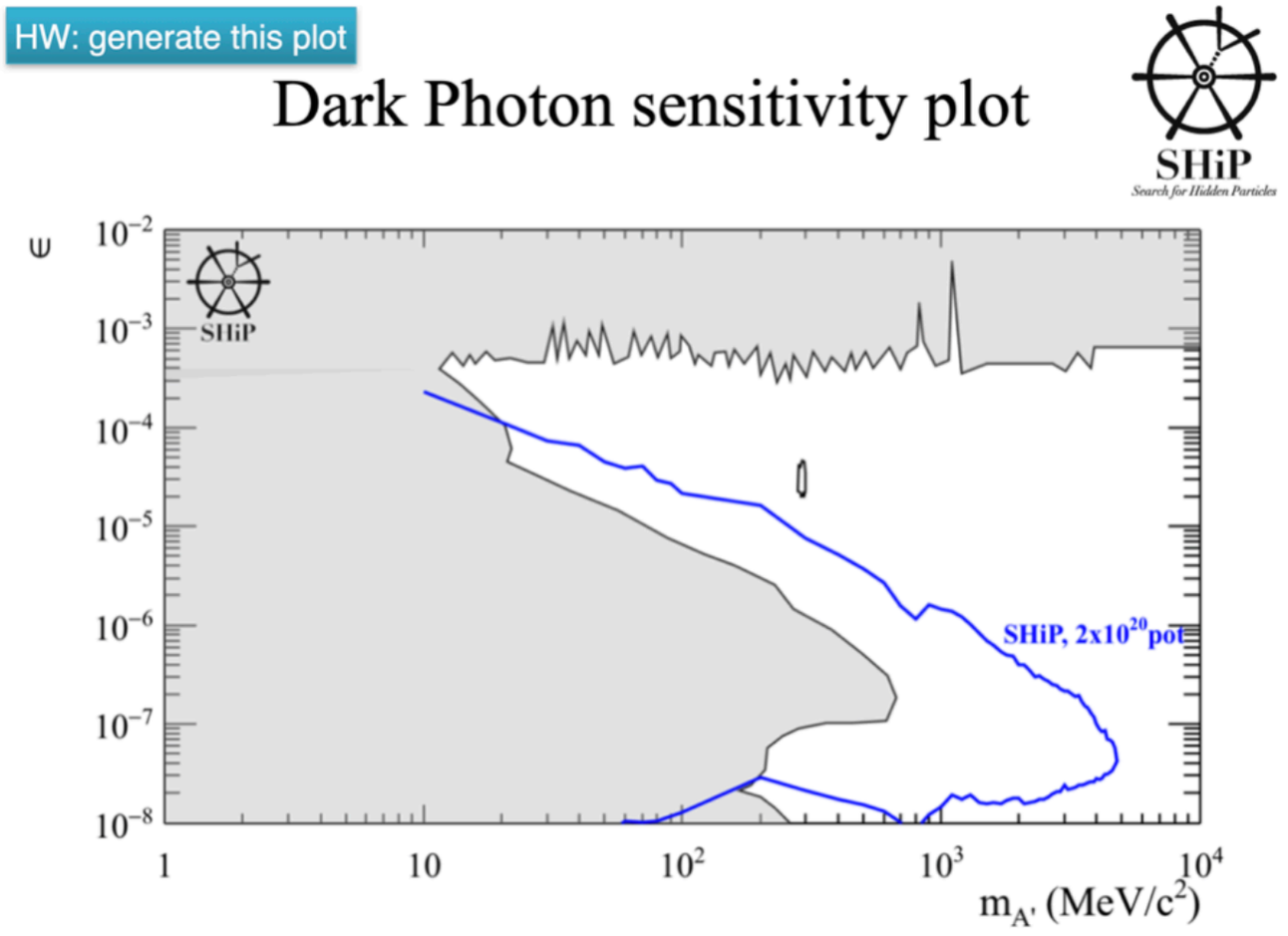
Problem 2

HWs (K. Lee's lecture on Dark world)

Homework

Make the sensitivity plot for dark photon at SHiP experiment (p.60 of this material) following the method used in the HNL case. Condition for the plot is N_prod >1 for 5 years run.
You can find formulae and numbers in the paper, JHEP 04 (2019) 077 and this talk.
Please set all efficiencies to be 1. For simplicity, only the following production and decay processes are considered.

HW: generate this plot



Problem 3

Lecture by Prof. T. Sakaguchi on heavy ion physics)

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Fieldwork (if you have spare time)

- Pick one of two topics below
- ALICE has a detector upgrade plan for LHC Run3 and Run4. Summarize the upgrade plan and discuss new physics knowledge to gain (pick your favorite of two) expected from the upgrade, compared to what we have learned with the current detector system.
- FCC has ~10 times higher center mass of energy available compared to LHC. Summarize the new probes (pick your favorite of two) to be available at the FCC. Also discuss what kind of new physics knowledge that the new probes can bring in, compared to what we have learned at LHC.

1/8/2021 T. Sakaguchi @ Saga U Lecture 56

References

1, K. Yagi, T. Hatsuda and Y. Miake, "Quark-Gluon Plasma", Cambridge University Press (2005)

2, C-Y Wong, "Introduction to High-Energy Heavy-Ion Collisions", World Scientific (1994)

Japanese References (sorry…)

3, 秋葉康之「クォーク・グルーオン・プラズマの物理」（物理学最前線３）共立出版、2014年

4, 鷲見義雄「原子核物理入門」裳華房、1997年

Next Session

- 21/Jan. 10:30 Self Introduction.
  (This replaces a welcome party, which is held every year.)

- Saga members: please come to the room 318.