Massachusetts Institute of Technology

Department of Physics

Course:	8.701 – Introduction to Nuclear and Particle Physics
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Discussion Problems

from recitation on **September 24th, 2020**

Problem 1: $A \to B + B$

- Is $A \to B + B$ a possible process in the ABC theory?
- Suppose a diagram has n_A external A lines, n_B external B lines, and n_C external C lines. Develop a simple criterion for determining whether it is an allowed reaction.
- Assuming A is sufficiently heavy, what is the most likely decay mode, after $A \to B + C$? Draw a Feynan diagram for each decay.

- 1) No. The process is not possible.

  2) Allowed if (and only if) n_A, n_B, and n_C are either all even or all odd.

  Take the allowed diagram and snip every internal line. We now have $n'_A = n'_B = n'_C = N$ 'external' lines, where N is the number of vertices. When we now reconnect the internal lines, each join removes two 'external' lines of one species. Thus when they are all back together, we have $n_A = N - 2I_A$, $n_B = N - 2I_B$, and $n_C = N - 2I_C$, where I_A is the number of internal A lines, and so on.Clearly, they're all even, or all odd, depending on the number of vertices.

Given n_A, n_B, and n_C, pick the largest of them (say, n_A) and draw that number of vertices, with A, B, C as 'external' lines on each one. Now just connect up B lines in pairs (converting two 'external' lines into one internal line, each time you do so), until you're down to n_B – as long as nA and nB are either both even or both odd, you will obviously be able to do so. Now do the same for n_C. We have constructed a diagram, then, with n_A external A lines, n_B external B lines, and n_C external C lines.

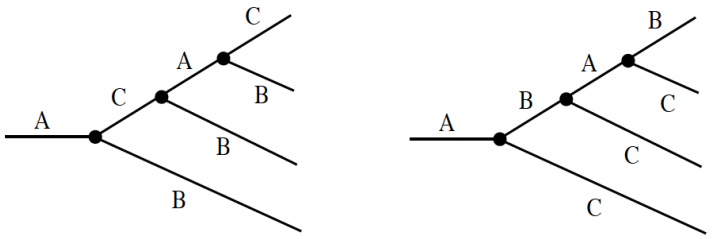

Figure 1: Answer.

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