PYL127 -2020

Problem Set 1 – Misc Basic Ideas

The following problems highlight the issues that you should pay attention to regarding the material covered in the lecture on Laws of motion, especially frames of reference. So do solve them before you get to constraints and degrees of freedom. All problems are in rectangular cartesian coordinate system unless stated otherwise.

1. Write the time and spatial coordinates as a column vector and express space-time translations as linear operations on the vector.

   - Show that the set of all these transformations forms a group. Importantly, thata combination of two translations is also a translation.
   - Verify that space time translation operations commute.

2. Write, explicitly, a rotation matrix (in three dimensions) in temsrms of axis and angle.

   - Verify, by explicit operation, that a rotation matrix (i) is orthogonal (ii) with determinant +1
   - Verify that product of two rotations is not a commutative process unless the axes are the same

3. Now combine space-time translations with rotations and show that the set of resulting set forms a group.

4. Suppose that you rotate first and then translate. Compare that with what you would get if you reversed the order.

We now introduce Galilean velocity transformations. Pure velocity transformations, without rotation or translation, are called boosts. All frames are inertial frames.

1. An inertial frame S_2 moves with a velocity $|vecV$ with respect to another frame S_1. Symbolically, write down the expression for the galilean transformation that connects them. It would involve translations, rotations and boosts.

2. Show that the set of all boosts itself forms a commutative group.Commutative groups are also called Abelian.

3. Consider a body A on which another body B acts by applying a force which depends only on the instantaneous separation (distance) between the two bodies. Show that it is completely consistent with principle of relativity under Galilean transformations.

4. Suppose that the force also depends on their relative velocity. Would it still be convenient with relativity?