Technische Universität München
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Mechanik (Theoretische Physik 1)

Sommersemester 2018

Abgabe bis Freitag, 13.04.18, 12:00 neben PH 3218.

Übungsblatt Nr. 1 Dieses Blatt wird in den Übungen vom 16.04. - 20.04.18 besprochen.

Aufgabe 1:
Helical trajectory 3 Punkte

Consider a particle moving in a helical trajectory $\mathbf{r}(t) = (x(t), y(t), z(t))$ with respect to a reference frame F, with the helix revolving around the z axis of F. At $t = 0$ the particle lies at $\mathbf{r}(0) = (L, 0, 0)$. The projection of $\mathbf{r}$ on the xy plane, $\mathbf{r}_{xy} \equiv (x(t), y(t), 0)$, moves around the origin of the xy plane counter clockwise, with uniform circular motion, completing a revolution every T seconds. Meanwhile the z coordinate increases uniformly with time, changing by h units in every revolution. What are the equations of the trajectory, the speed and acceleration in Cartesian coordinates? What are their expressions in cylindrical coordinates?

Aufgabe 2:
Helical Trajectory in different reference frames 3 Punkte

Derive the equations for the same trajectory, velocity and acceleration as in Problem 1, but in the following reference frames: i/. A frame F_2 that moves with uniform acceleration a_z in the positive z direction, considering that at $t = 0$ the frame F_2 overlaps with the frame F of problem 1, with zero relative velocity. ii/. A frame F_3 with rotates uniformly in time around the z axis of the frame F of problem 1, with a positive angular velocity $\omega = 2\pi/T$. Would the forces that appear to act on the particle be the same in all frames F, F_2, F_3 (answer this last question qualitatively)?

Aufgabe 3:
Velocity in spherical coordinates 2 Punkte

A trajectory can be defined in either Cartesian coordinates $(x(t), y(t), z(t))$, or in spherical coordinates $(r(t), \theta(t), \phi(t))$. What is the line element $ds^2 = dx^2 + dy^2 + dz^2$ in spherical coordinates? Use the result to infer the value of the magnitude of the velocity vector, $|\mathbf{v}|^2 = \dot{x}^2 + \dot{y}^2 + \dot{z}^2$, in spherical coordinates.

Aufgabe 4:
Shape of trajectories with conserved angular momentum **2 Punkte**

Suppose that angular momentum $\mathbf{L} = \mathbf{r} \times \mathbf{p}$ is conserved, with $\mathbf{r}$ taken as the position vector with respect to the origin of a given reference frame. The next diagrams show possible planar trajectories, with the origin of the reference frame highlighted as a thick dot. Are the trajectories compatible with angular momentum conservation?