HOW EINSTEINIAN TIDE FORCE AFFECTS BEAM IN A STORAGE RING*

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Abstract

In this paper, we will introduce Einsteinian tide force into a storage ring, and discuss the beam characteristic in a storage ring, we can see that it is quite different from Newtonian tide force act on beam in a storage ring which we know very well. We also discuss the method to measure the beam instability in storage ring caused by these two different tide forces.

EINSTEIN'S TIDE FORCE ON BEAM DYNMAICS

It's well know that tidal force, predicted by Einstein's general relativity is quite different from Newtonian tidal force. Einstein's tidal force will affects the beam in a storage ring and change the beam position directly. So it is a new physics model on beam instability in a storage ring.

In the Minkowski space-time, Let an x–y plane be defined by a storage ring and z-axis be in the direction of the normal of the ring. Let us consider the motion of the beam in the storage ring in a perturbed space-time, $ds^2 = -dt^2 + (1+h_+)dx^2 + (1-h_+)dy^2 + 2h_\times dxdy + dz^2$ (1)

where $h_+ = A_+ \cos(\omega_g t - 2\pi z / \lambda_g)$, $h_\times = A_\times \cos(\omega_g t - 2\pi z / \lambda_g)$, Einstein amplitude A_+ and $A_\times$ are two independent mode. ω_g is the angular frequency of Einstein tidal force. (The c = 1 unit is used throughout the paper). Two modes of Einsteinian tide force are shown in figure 1, from that one can see how the Einsteinian tide force affects beam in a storage ring.

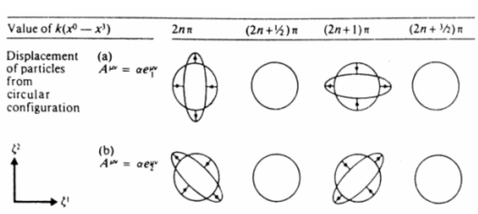

Fig 1: two mode of Einsteinian tide force

$$n^1 = A_1 \cos(\omega_a t + \varphi_1) + \frac{\omega_g^2 (A_+ x + A_\times y)}{2(\omega_g^2 - \omega_a^2)} \cos(\omega_g t) \quad (2)$$

$$n^2 = A_2 \cos(\omega_a t + \varphi_2) + \frac{\omega_g^2 (A_\times x - A_+ y)}{2(\omega_g^2 - \omega_a^2)} \cos(\omega_g t) \quad (3)$$

After calculation and simplification, one can obtain three equations[3], two describe the local changes of the beam position with time in a storage ring, and the third one describes COD change of the beam in a storage ring, show as follow,

$$\Delta l = \frac{R\omega_0 \omega_g^2 \sin\left(\frac{\pi\omega_g}{\omega_0}\right)}{(\omega_g^2 - \omega_a^2)(4\omega_0^2 - \omega_g^2)} \cdot \left[\omega_g A_+ \cos\left(\frac{\pi\omega_g}{\omega_0}\right) - 2\omega_0 A_\times \sin\left(\frac{\pi\omega_g}{\omega_0}\right)\right] \quad (4)$$

CONCULSION

Different from Newtonian tidal force which affects the magnets and BPMs in storage ring, Einstein tidal force changes the particle beam position directly, and has not be distinguished yet. One method to recognize it is co-identity beam signals from difference ring in the worldwide side, and this method also can help us to dispel the noise of beam signal, this is the best way. This experiment may help us find new physics.

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REFERENCES

[1] Dong Dong. Huang Chao-Guang, Commun. Theor. Phys. 40 (2003) pp. 299-300.

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