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# Effect of Magnetic Force of the Earth, Solar Radition Pressure and Shadow of the Earth on the Motin and Stability of the Inextensible Cable Connected Satellites System

**Research Article**

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**Abstract:** The proposed work is devoted to the study of the effect of magnetic force, solar radiation pressure and shadow of the earth on the motion and stability of two cable connected satellites. The satellites are considered to be material particle connected by light flexible, inextensible and non-conducting string. The body of the satellites acquires small charges through the owing to their scudding through the earth magnetic lines of force. This movement of charges through the magnetic field causes the lorentz force to come in to play, besides the ever present earth's gravitational field of force will move along a keplerian orbit.

**Keywords:** Equation of motion, Effect of magnetic force, shadow of the earth, centre of mass, satellites, solar radiation pressure.


## 1. Introduction

The entire work is directed generalization R. W. Bryant (1961) studied "the effect of solar radiation pressure on the motion of artificial satellites" R. B. Sigh and V. G. Demin [16], "about the motion of a Heavy flexible string attached to the satellite field of Attraction" and investigate the problem in two and three dimensional cases. S. K. Das [4] studied "the effect of magnetic force on the motion of a system of two cable connected satellites in orbit". Kumar (2018) studied liberation points of a cable – connected satellites system under the influence of solar radiation pressure, earth's magnetic field, shadow of the earth and air resistance: circular orbit. Kumar and Bhattacharya [6] studied the stability of equilibrium positions of two cable-connected satellites under the influence of solar radiation pressure, earth's oblateness and earth's magnetic field. Kumar and Srivastava [6] obtained the equations of motion of a system of two cable-connected artificial satellites under the influence of some perturbative forces. S. Kumar and U. K. Srivastava and P. K. Bhattacharya [7]. Studied the boundary of motion of a system of two cable connected satellites under some perturbations with some dependent bilateral constraint. Many classical results of two cable connected satellites system may be verified from our generalized result for example, works of Sinha and Singh [18, 19], Khan and Goel [5], Kumar (2018), Kumar and Singh (2010) etc.

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## 2. Equation of Motion

The equation of motion of two particles of masses $m_1$ and $m_2$ respectively can be written by using Lagrange's equation of motion of the first kind in the form

$$\begin{aligned} m_1 \ddot{\vec{r_1}} &= -\frac{m_1 \mu \vec{r_1}}{r_1^3} + \lambda(\vec{r_1} - \vec{r_2}) + Q_1(\vec{r_1} \times \vec{H}) + \psi B_1 \vec{n} \\ m_2 \ddot{\vec{r_2}} &= -\frac{m_2 \mu \vec{r_2}}{r_2^3} + \lambda(\vec{r_2} - \vec{r_1}) + Q_2(\vec{r_2} \times \vec{H}) + \psi B_2 \vec{n} \end{aligned} \tag{1}$$

Let $\vec{r_1}$ and $\vec{r_2}$ be radius vectors of the particles of the masses $m_1$ and $m_2$ respectively with respect to the attracting centre. Let $l_0$ denotes the length of the string connecting the two particles. Then the constraint of the system is given by the following inequality.

$$|\vec{r_1} - \vec{r_2}|^2 \leq \ell_0^2 \tag{2}$$

Let $\vec{R}$ denotes the radius vector of their centre of mass, then

$$\vec{R} = \frac{m_1\vec{r_1} + m_2\vec{r_2}}{m_1 + m_2} \tag{3}$$

Adding the two equations in (2), we get

$$M\ddot{\vec{R}} + M\left(\frac{m_1\vec{r_1}}{r_1^3} + \frac{m_2\vec{r_2}}{\vec{r_2}}\right) = 0 \tag{4}$$

where $M = m_1 + m_2$ and

$$\begin{aligned} A &= \frac{p^3}{\mu\ell_0}\left[\frac{B_1}{m_1} - \frac{B_2}{m_2}\right] = \text{Solar pressure force parameter} \\ B &= \frac{m_1}{m_1 + m_2}\left(\frac{Q_1}{m_1} - \frac{Q_2}{m_2}\right)\frac{\mu_E}{\sqrt{\mu p}} = \text{Magnetic force parameter} \\ \Psi_1 &= \text{Shadow force parameter} \\ \lambda_\alpha &= \frac{p^3\overline{\lambda}}{\mu} p = \text{focal parameter} \end{aligned}$$

Thus, we have a new set of differential equations characterizing the motion of the particle of mass $m_2$ in the following form:

$$\begin{aligned} x'' - 2y' - 3x\rho - A\rho^3\psi_1 \cos\in\cos(v-\alpha) &= \lambda_\alpha\rho^4 x - \frac{B\cos i}{\rho} \\ y'' + 2x' + A\rho^3\psi_1\cos\in\sin(v-\alpha) &= \lambda_\alpha\rho^4 y - \frac{B\rho'}{\rho^2}\cos i \\ z'' - z' + A\rho^3\psi_1\sin\in &= \lambda_\alpha\rho^4 z - \frac{B}{\rho}\left[\frac{\rho'}{\rho}\cos(v+w) + \frac{1}{\mu_E}\left(3p^3\rho^2 - \mu_E\right)\sin(v+w)\right]\sin i \end{aligned} \tag{5}$$

Where

$$\left.\begin{aligned} A &= \tfrac{p^3}{\mu\ell_0}\left[\tfrac{B_1}{m_1} - \tfrac{B_2}{m_2}\right] | \\ B &= \tfrac{m_1}{m_1+m_2}\left(\tfrac{Q_1}{m_1} - \tfrac{Q_2}{m_2}\right)\tfrac{\mu_E}{\sqrt{\mu p}} \\ \lambda_\alpha &= \tfrac{p^3\bar{\lambda}}{\mu} \end{aligned}\right\} \tag{6}$$

The condition of constraint given by takes the form

$$\xi^2 + \eta^2 + \zeta^2 \leq 1 \tag{7}$$

where A, B and $\lambda_\alpha$ are given by (6) the condition of constraint given by (8) takes the form

$$x^2 + y^2 + z^2 \leq \frac{1}{\rho^2} \tag{8}$$

Thus (5) is the set of normalized and linearized differential equations which governs the motion of one of the particles of the system with origin at the centre of mass of the system.

It follows from the equation of motion given by (5) that a system of two satellites is under the shadow of the earth when the shadow function $\psi_1 = 0$ and in that case the system will have no sun light effect and hence the term containing the perturbative parameter $\psi_1$ on the left hand side of the equation (5) will vanish. But as soon as the system will experience the sun light effect, the shadow function $\psi_1 = 1$ and in that case we have the same system with magnetic force and solar radiation pressure as perturbative forces.

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