Erratum: Corrigendum to "Effect of dark energy models on the energy content of charged and rotating black holes" [Chinese Phys. C, 46 (2022) 015101]

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Abstract: In Liaqat and Hussain (2022) it was proved that the effect of dark energy with $\omega_n = -\frac{1}{3}$, causes a reduction in the energy content of the quintessential charged-Kerr spacetime. This result needs correction as it is observed that the contribution of dark energy first decreases the total energy of the underlying spacetime for smaller values of radial coordinate r and then increases the energy for comparatively larger values of r.

Keywords: dark energy, quintessential charged-Kerr black hole, Energy content

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In [1], we examined the effects of dark energy on the gravitational energy for the quintessential charged-Kerr black holes by approximate Lie symmetry approach. It was shown that the gravitational energy of the charged-Kerr black hole spacetime surrounded by dark energy decreased due to the presence of the cosmological constant ($\omega_c = -1$) and quintessence dark energy ($\omega_q = -\frac{2}{3}$) [1]. Whereas, for the case of frustrated network of cosmic strings ($\omega_n = -\frac{1}{3}$) the contribution in energy of the charged-Kerr black hole due to the presence of dark energy term E_n was observed to be positive for different values of dark energy parameter α (as shown in FIG. 7.) while FIG. 8. shows the effect of dark energy with different values of spin a. We observed there, that if the dark energy parameter α is initially small, then the value of E_n will increase primarily and then it showed a gradual decline for the larger values of α [1]. This result needs correction.

Therefore in this corrigendum, we present the effects of dark energy on the energy content of the charged-Kerr black hole surrounded by the dark energy for $\omega_n = -\frac{1}{3}$. It is observed that at this value of the equation of state parameter, the presence of the dark energy first decreases the energy content of the charged-Kerr black hole surrounded by the dark energy and then increases the energy. This is shown by the graphical results.

I. GRAVITATIONAL ENERGY OF THE QUINTESSENTIAL CHARGED-KERR BLACK HOLE FOR $\omega_n = -\frac{1}{3}$

As shown in [1], in the case of $\omega_n = -\frac{1}{3}$, we get the following re-scaling factor of energy for the charged-Kerr spacetime surrounded by dark energy

$$M_{C-K-n} = \frac{M}{2r}\left[1 - \frac{Q^2}{2M^2}\right] + \frac{3Ma}{4r^2} + \frac{M\alpha}{2r}\left[\frac{1}{1-\alpha} - \frac{a}{2r}\right] \quad (1)$$

It was observed, for $\omega_n = -\frac{1}{3}$, the total energy in the charged-Kerr spacetime surrounded by dark energy varies from the energy in the charged-Kerr spacetime by the following expression [1]

$$E_n = \frac{M\alpha}{2r}\left[\frac{1}{1-\alpha} - \frac{a}{2r}\right] \quad (2)$$

In order to analyze the significant features of dark energy, we sketch the expression (2) versus α and radial distance r.

From FIG. 1, it is observed that for some values of α and for smaller values of r the value of E_n is negative which shows that it decreases the energy content of the underlying spacetime, and for some values of α and relatively bigger values of r, the value of E_n is positive and

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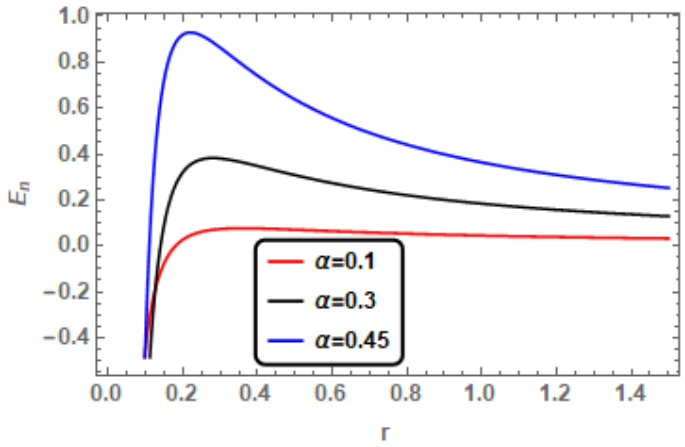

Fig. 1. (color online) plots showing the behavior of E_n for the quintessential charged-Kerr black hole for $\omega_n = -\frac{1}{3}$ with different values of α and a fixed value of $M = 1$, $a = 0.4$.

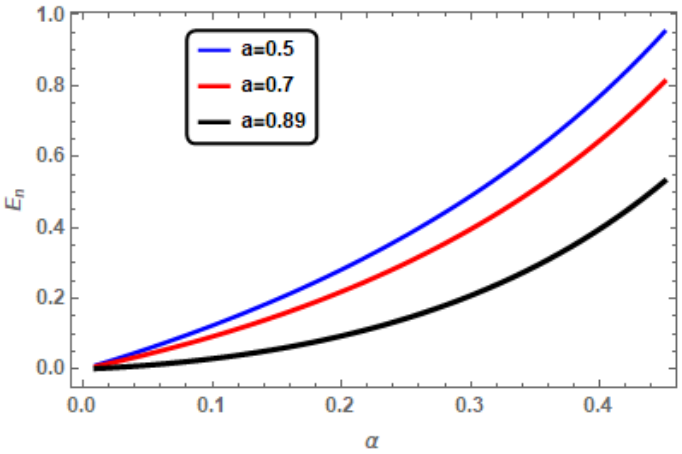

Fig. 2. (color online) plots showing the behavior of E_n for the quintessential charged-Kerr black hole for $\omega_n = -\frac{1}{3}$ with different values of a, $0 < \alpha < 1/2$ and a fixed value of $M = 1$ and $r = 0.4$.

hence increases the energy content of the CK spacetime (as evident from (1)). Hence, we observe that the contribution of dark energy term for $\omega_n = -\frac{1}{3}$, first decreases the total energy of the underlying spacetime for smaller values of radial coordinate r and then increases for comparatively larger values of r. FIG. 2 depicts the increasing behavior of E_n for different values of spin parameter a.

Therefore, in view of the above discussion it is concluded that the result given in [1] must be stated as

Remark: *The effect of cosmological constant and quintessence decreases the energy of the charged-Kerr black hole surrounded by dark energy, whereas the effect of a frustrated network of cosmic strings decreases the energy of the charged-Kerr black hole surrounded by dark energy for some values of α and for smaller values of r and increases the energy for some values of α and relatively bigger values of r as evident from* (1).

References

[1] A. Liaqat, I. Hussain, Chinese Physc. C **46**, 015101 (2022)