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DOES THE HETEROTIC SUPERSTRING THEORY CONTAIN CLOSED TIME-LIKE LINES?

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The following are corrections to errors in the published paper:

- (1) On p. 559, in lines 17, 18, printed as “... $c = 0$, and also $\Lambda = 0$, as required for anomaly freedom, while solutions with $c < 0$ are ruled out.” should read as “... $c = 0$, but $\Lambda < 0$, while solutions with $c < 0$ are ruled out.”
- (2) On p. 570, in Eq. (67), printed as

$$\left\{ -L_1 + 2L_2 - \frac{1}{6}L_3 + \frac{1}{32}[\dots] \right\}$$

should read

$$\left\{ L_1 - 2L_2 + \frac{1}{6}L_3 + \frac{1}{32}[\dots] \right\}$$

- (3) On p. 570, Eq. (75) should read

$$L_1 - 2L_2 + \frac{1}{6}L_3 = \frac{3m^8}{16}.$$

- (4) On p. 571, Eq. (76) should read

$$L^{(4)} = C\kappa^4 m^8,$$

- (5) On p. 571, Eq. (77) should read

$$C = \frac{57\zeta(3)A_r^3}{64}.$$

*Temporary address.

- (6) On p. 571, Eq. (78) should read

$$T_i^j = C\kappa^4 \left(\frac{16}{3}m^6 R_i^j - m^8 \delta_i^j \right).$$

- (7) On p. 571, in Eqs. (79), (80) and (81), and on p. 572, in Eqs. (82) and (83), printed as “ C ”, should read “ $-C$ ”.

- (8) On p. 572, lines 6–10 should read

the requirements for the theory to be tachyon-free at quadratic order, and since the constant C is positive in the superstring theory — that m is real [as it must be if the metric (10) is to be real] only if λ is negative definite.

In this case, substitution into Eq. (80) yields the equation

$$\kappa^{-2} \left(1 - \frac{1}{\sqrt{C}} \sqrt{-\frac{4\lambda}{3m^4} - 3A_0 - A_2 - \frac{4\phi_0^2}{3m^4}} \left(-\frac{8\lambda}{9m^4} + A_0 + \frac{1}{3}A_2 + \frac{\phi_0^2}{9m^4} \right) \right) = 0. \quad (84)$$

- (9) On p. 572, Eq. (85) should read

$$C = \frac{1}{9} \left(-\frac{4\lambda}{3m^4} - 3A_0 - A_2 \right) \left(-\frac{8\lambda}{3m^4} + 3A_0 + A_2 \right)^2, \quad (85)$$

- (10) On p. 572, lines 13–23 should read

which could be solved for arbitrary $\lambda < 0$ if A_0 and A_2 were free parameters, satisfying the inequality (57). In the heterotic superstring theory, however, $A_0 \equiv B$ and $A_2 \equiv -A_0$ are defined independently of C , and therefore Eq. (85) determines λ through the cubic equation

$$\tilde{\lambda}^3 - 3B^2\tilde{\lambda} - \left(2B^3 + \frac{9}{4}C \right) = 0, \quad (86)$$

where

$$\tilde{\lambda} = -\frac{4\lambda}{3m^4}. \quad (87)$$

A nonvanishing cosmological constant in the reduced four-dimensional heterotic superstring theory can be attributed to the bilinear condensation of fermion–anti-fermion pairs in the internal space, and may *a priori* be positive or negative (see M. D. Pollock, *Int. J. Mod. Phys. D* **17** (2008) 81, Appendix A, and references therein).

- (11) On p. 575, lines 24–29 should read

This becomes an issue when the cosmological constant is negative definite, in which case the vacuum state is anti-de Sitter space, defined by the equation

$$R_{ij} = -\Lambda g_{ij} = A g_{ij}, \quad (97)$$

where A is positive.

- (12) On p. 579, lines 30–33 should read
Euclidean solutions are to have a physical meaning. If $k = 1$, for example, the anti-de Sitter metric has to be formulated in the Euclidean coordinate system (119). In that
- (13) On p. 581, the discussion of lines 5–29 does not apply.