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Erratum: Superboost transitions, refraction memory and super-Lorentz charge algebra

Geoffrey Compère, Adrien Fiorucci and Romain Ruzziconi

Université Libre de Bruxelles and International Solvay Institutes, CP 231, B-1050 Brussels, Belgium

E-mail: gcompere@ulb.ac.be, afiorucc@ulb.ac.be, rruzzico@ulb.ac.be

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1 List of corrections

Hereby, we bring to your attention the following typos and mistakes in [1].

After correcting one algebraic mistake and one typo, equation (5.31) must read as

$$\begin{aligned}\oint \bar{H}^{(0)}_\xi = \frac{1}{16\pi G}\oint \mathrm{d}^2\Omega \left[4fM + 2Y^A N_A + \frac{1}{16}Y^A\partial_A(C_{BC}C^{BC})\right] \\ + \frac{1}{16\pi G}\oint \mathrm{d}^2\Omega \left[\frac{1}{2}f\left(N^{AB}+\frac{1}{2}q^{AB}\mathring{R}\right)\delta C_{AB} - 2\partial_{(A}f\mathring{U}_{B)}\delta q^{AB}\right. \\ \left. -fD_{(A}\mathring{U}_{B)}\delta q^{AB} - \frac{1}{4}D_C D^C f C_{AB}\delta q^{AB}\right].\end{aligned} \tag{1.1}$$

Equation (5.32) is the modification of the surface charge codimension 2-form $\boldsymbol{k}_\xi[g,\delta g]$ under the incorporation of a covariant Iyer-Wald ambiguity $\boldsymbol{Y}[g,\delta g]$. Its proof involves Cartan's magic formula acting on $\boldsymbol{Y}$. Here however, $\boldsymbol{Y}$ is not proven to be covariant in terms of the bulk metric alone and therefore that identity cannot be used. As a consequence, although (5.33)–(5.36) are correct, the comment just below (5.36) must be deleted.

Instead, the boundary counterterm $\boldsymbol{Y}$ removes all linear in r divergences without affecting the finite pieces by construction. According to (1.1), the finite charge in (5.37) must read as

$$\oint H_\xi = \oint \bar{H}^{(0)}_\xi. \tag{1.2}$$

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We checked that the u derivative of this charge is equal to the symplectic flux $\oint d^2\Omega\, \omega^r[g, \delta_\xi g, \delta g]$ where ω^r is defined in (5.26). The surface charge expression is therefore now correct. (5.38) is therefore incorrect and the non-integrable part reads as

$$\Xi_\xi[g,\delta g] = \frac{1}{16\pi G}\oint d^2\Omega \left[\frac{1}{2} f\left(N^{AB}+\frac{1}{2}q^{AB}\mathring{R}\right)\delta C_{AB} - 2\partial_{(A} f \mathring{U}_{B)}\delta q^{AB} \right.$$
$$\left. - f D_{(A}\mathring{U}_{B)}\delta q^{AB} - \frac{1}{4} D_C D^C f C_{AB}\delta q^{AB}\right]. \tag{1.3}$$

Due to the modification of the surface charge (5.37), the algebra of charges, described in (5.68)–(5.70), closes under the modified bracket. (5.68) should be replaced by

$$\delta_{\xi_1} H_{\xi_2}[g] + \Xi_{\xi_1}[g, \delta_{\xi_2} g] = H_{[\xi_2,\xi_1]}[g] + \mathcal{K}_{\xi_1,\xi_2}[g]. \tag{1.4}$$

There is no anomalous term and (5.70) should be removed. Equation (5.69) should be replaced by

$$\Xi_{\xi_1}[g,\delta_{\xi_2} g] = \frac{1}{16\pi G}\oint d^2\Omega \left[\frac{1}{2} f_1\left(N^{AB}+\frac{1}{2}q^{AB}\mathring{R}\right)\delta_{\xi_2} C_{AB} - 2\partial_{(A} f_1 \mathring{U}_{B)}\delta_{\xi_2} q^{AB} \right.$$
$$\left. - f_1 D_{(A}\mathring{U}_{B)}\delta_{\xi_2} q^{AB} - \frac{1}{4} D_C D^C f_1 C_{AB}\delta_{\xi_2} q^{AB}\right] - \delta_{\xi_2}\Delta H_{\xi_1}. \tag{1.5}$$

The comments under (5.72) must be modified as follows: "The charge algebra (5.68) closes under the modified bracket introduced in [2]. Even staying…". Accordingly, the last sentence of the introduction before the *Note added* should read as "We finally show that the generalized BMS charges obey the algebra under the modified Dirac bracket introduced in [2]".

The technical restriction (2.4) can be better reformulated as the boundary condition $\sqrt{q} = \sqrt{\bar{q}}$ where $\partial_u \bar{q} = 0$ and $\delta\bar{q} = 0$. Then $\partial_u q_{AB} = 0$ follows from Einstein's equations. The residual diffeomorphisms (2.10) preserve the condition $\sqrt{q} = \sqrt{\bar{q}}$. In the introduction of section 2.1., r is a parameter along the null geodesic congruence which is not necessarily affine. The right-hand side of (2.23) needs to include the additional term $+\frac{1}{8} D_A D_B D_C Y^C C^{AB}$. In addition, note that all $\int d^2\Omega$ should read as $\oint d^2\Omega$, $C_{AB} = \wr(u^{-1})$ in footnotes 4 and 5 should read as $C_{AB} = o(u^{-1})$; the subscripts c in section 3.1 are better written C in order to avoid confusion with the indices a, b, c; all subscripts (0) in section 5.3 are better written as (fin) in order to match the notation of section 5.4. The integration variable in (5.10) should be $du dr d^2x$ while $d^2\Omega$ in (5.21) is $\sqrt{q} d^2x$; the sign of the r divergent part in (5.24) should be the opposite; in the first term of (5.26), the q_{AB} should be q^{AB}; there is a "hat" missing on N_A^{vac} in (5.65). Finally, the "spin effect" in the box in figure 2 should better be called "spin and center-of-mass memory".

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References

[1] G. Compère, A. Fiorucci and R. Ruzziconi, *Superboost transitions, refraction memory and super-Lorentz charge algebra*, *JHEP* **11** (2018) 200 [arXiv:1810.00377] [INSPIRE].

[2] G. Barnich and C. Troessaert, *BMS charge algebra*, *JHEP* **12** (2011) 105 [arXiv:1106.0213] [INSPIRE].

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