Balance equations for linear momentum and center of mass of isolated post-Newtonian systems

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Abstract

We revisit the problem of flux-balance equations for isolated post-Newtonian matter systems due to the emission of gravitational waves. In particular we show by a local derivation confined to the system, using the expression of radiation-reaction forces up to the 3.5PN order, that not only the energy, angular momentum and linear momentum of the system, but also the position of its center of mass, obey some (non-trivial) flux-balance equations. The balance equation for the center-of-mass position completes the description of the secular evolution by gravitational waves of relativistic post-Newtonian isolated matter systems. We then confirm this result by a direct computation of the gravitational-wave fluxes at future null infinity, obtaining the full multipole moment expansion of the flux associated with the center-of-mass position (probably new with this paper), and rederiving as well the known multipole moment expansions of the fluxes of energy, angular momentum and linear momentum. We also check our analysis by a direct calculation of radiation-reaction effects in the case of compact binary systems.

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