In this paper, the authors present a comprehensive approach for the stable and contact-free simulations of dense rigid particle suspensions. In the absence of forces and torques, it is well-known that rigid particles in a Stokesian fluid cannot collide due to lubrication effects. The authors achieve this by extending the method of Lu et al and guarantee a minimum separation by treating all hydrodynamic interactions implicitly which enables them to take large time steps, even in dense suspensions. The authors demonstrate the effectiveness (both in terms of accuracy and stability) of their approach by many numerical examples and also provide a detailed quantification of the errors introduced by their contact algorithm.

Upon clarifications by the authors, I believe that calling the time stepping schemes globally implicit/locally implicit is a misnomer. The authors are solving the following system of differential equations using the explicit Euler method

$$\frac{d\mathbf{c}_k}{dt} = \mathbf{u}_k \,, \quad \frac{d\theta_k}{dt} = \omega_k \,. \tag{1}$$

The authors propose two methods for evaluating the rigid body motions $\mathbf{u}_k$ and ω_k. In the globally implicit method, the rigid body motions are computed by solving a mobility problem for the current configuration. In the locally implicit solve, the authors approximate the solution of the mobility problem by doing a local solve for each of the rigid bodies and using the contributions from the rest of the rigid bodies and the walls from the previous time step. While the evaluation of the rigid body motions $\mathbf{u}_k$ and ω_k requires the solution of a PDE, their solver is still not an implicit one since the authors use the geometry (and hence the locations, $\mathbf{c}_k$ and orientations θ_k) corresponding to the current time step. Unfortunately, I was unable to come up with a nomenclature for this scheme that reflected the work done at each time step but still relied on an explicit time-stepper.

That being said, their solver is one of the first works to combine a lot of existing tools to enable stable and accurate simulations of rigid body particles even in dense settings which is numerically a difficult task. Furthermore, to the best of my knowledge, this is the first work to provide a detailed quantification of the irreversibility effects of the contact algorithm used in dense rigid body suspensions. Thus, I strongly recommend publication of this manuscript, but urge the authors to propose a more appropriate nomenclature. I leave this change to the authors and do not feel the need for another round of revisions.