An asymptotic framework for gravitational scattering

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Applying to graduate school this Fall!

Motivation

Massive body scattering hasn't been formulated precisely
Discrepancies in PM calculations of angular momentum
Supertranslation dependence of Angular Momentum
--Precise formulation may help solve the discrepancies in PM

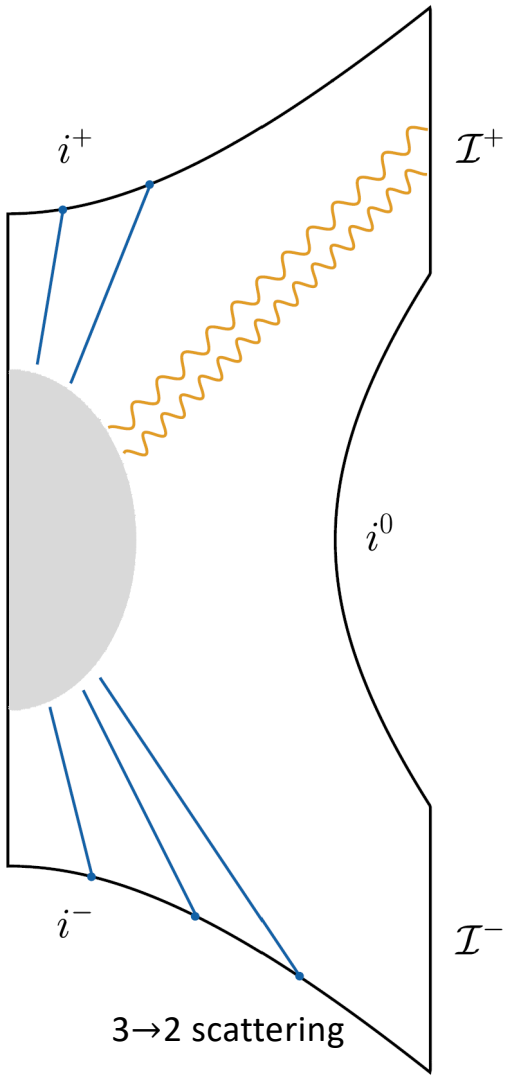
Standard Approach

Each infinity has its own symmetry group

Each infinity has its own conserved charges

Goal

get single BMS group and associated charges
for all five infinities (cf. Ashtekar, Strominger,…)



Step 1: obtain BMS and charges at all infinities (New for i^0 and $i^{\pm}$)

Null infinity: Bondi coordinates: $\{u, r, x^A\}$

Time-like/spatial infinity: Beig-Schmidt coordinates: $\{\tau, \rho, y^A\}$

Step 2: find coordinate transformations relating Bondi to Beig-Schmidt

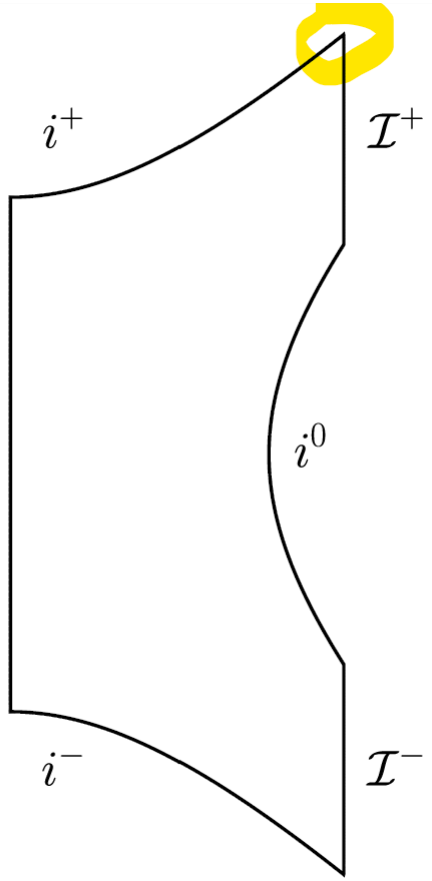
$$u = \tau e^{-\rho} + \alpha(\rho, y^A) + \tau^{-1} A(\rho, y^A) + o(\tau^{-1})$$
$$r = \tau \sinh \rho + \beta(\rho, y^A) + \tau^{-1} B(\rho, y^A) + o(\tau^{-1})$$
$$x^A = y^A + \tau^{-1} p^A(\rho, y^A) + \tau^{-2} q^A(\rho, y^A) + \tau^{-2} \log \tau q^A_{\log}(\rho, y^A) + o(\tau^{-2}).$$

Bondi Beig-Schmidt

After finding the free functions → obtain relations of Bondi and Beig-Schmidt quantities

$$Q^{i^+,\text{total}} = Q^{\mathcal{I}^+,\text{final}}.$$

All BMS charges match consistently -- New



Results – After matching 5 infinities

- conservation law (flux-balance law) over whole spacetime – New – After 268 equations!

$$\sum_{n=1}^{N^+} Q_n^{i^+} + \Delta Q^{\mathcal{I}^+} = Q^{i^0} = \sum_{n=1}^{N^-} Q_n^{i^-} + \Delta Q^{\mathcal{I}^-}, \tag{269}$$

- Definitions of Impact parameter and Spin
  - Spin is supertranslation invariant -- New
  - Impact parameter is not

Note that the final frame is supertranslated due to the memory effect. This must be taken into account during the post-Minkowskian calculations