

## Field equations of General Relativity via the variational principle

In the present work we deduce the field equations of General Relativity through the variational principle. By establishing an action  $S_g$  for the gravitational field and by taking its variation, it is possible to obtain Einstein's field equations in vacuum. Once the vacuum field equations have been deduced, it is possible to conclude that the interaction of matter with the gravitational field occurs through the energy-momentum tensor  $T_{\mu\nu}$ . Then, we obtain the field equations in the presence of a source by defining an action  $S_m$  for the matter involving  $T_{\mu\nu}$ , adding the action  $S_g$  for the gravitational field, and taking the variation with respect to  $g^{\mu\nu}$ . Finally, the variation of action for matter also leads to a definition of the energy-momentum tensor  $T_{\mu\nu}$  in terms of the variation of the Lagrangian density of matter  $\mathcal{L}_m$  with respect to the metric of the gravitational field.

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