

In this talk, we analyze the variation of the gravitational action on a bounded region of spacetime, whose boundary contains segments with various characters including null. We develop a systematic approach to decompose the derivative of metric variations into orthogonal and tangential components with respect to the boundary and express them in terms of variations of geometric objects associated to the boundary hypersurface. We suggest that a double-foliation of spacetime provides a natural and useful set-up for treating the general problem and clarifies the assumptions and results in specialized ones. In this set-up, we are able to obtain the boundary action necessary for the variational principle to become well-posed, beside the canonical structure of the theory, while keeping the variations quite general. Especially, we show that how one can remove the restrictions imposed on metric variations in previous works due to the assumption that the boundary character is kept unaltered. As a result, we find on null boundaries a new canonical pair which is related to the change in character of the boundary. The set-up and the calculation procedure are stated in a way that can be applied to other more generalized theories of gravity.