Some developments on higher order symmetries in gauge theories and gravity at null infinity

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The study of symmetries at null infinity and their connection with soft theorems via Ward identities has been the subject of intense research over the past decade. The organization of the symmetries in a clear - geometric - structure that reflects the subleading infrared effects has led to numerous interesting results, in particular the emergence of the Lw_{1+\infty} algebra of symmetries for gravity and the S-algebra of symmetries for Yang-Mills. In this talk we will show two geometric approaches we have developed to understand the role of these symmetry algebras at null infinity. First, we will review a previous adaptation of Stueckelberg's procedure to extend phase spaces at null infinity for Yang-Mills, and comment on its consistency with the so-called edge mode construction and its link with the S-algebra. Second, in the case of gravity, we will show a construction of the Lw_{1+\infty} algebra from soft theorems for gravity coupled to a scalar field, and some preliminary results on a high-spin-covariant derivative that deforms the wedge algebra and allows to define charges acting canonically on the phase space, in agreement with the literature. Finally, we will discuss possible future directions.