

## 博士論文公聴会の公示（物理学専攻）

学位申請者：平井隼人

論文題目：Towards Infrared Finite S-matrix

（赤外発散の生じない散乱行列の定式化における研究）

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場所：理学研究科 H棟 7階セミナー室（H701号室）

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論文要旨：

We study infrared dynamics in quantum electrodynamics towards the construction of well-defined S-matrix without infrared divergences. S-matrix is a fundamental quantity for the scattering theory of particles in quantum field theories. However, the conventional S-matrix for theories with massless particles is not well-defined due to the infrared divergences. This problem originates in the fact that the interactions mediated by low energy massless particles create infinitely long-range forces between charged particles. Therefore, the better understanding of infrared dynamics is necessary to improve the S-matrix theory. In the first half of this thesis, we focus on following three subjects that capture the universal features of the infrared dynamics; asymptotic symmetry, soft theorem, memory effect. We elucidate the fundamental properties of the charge conservation law associated with the asymptotic symmetry and develop the new relations among the three subject. In the last half, the proper asymptotic states for the infrared finite S-matrix is investigated. The Faddeev-Kulish(F-K) state has been known as a candidate for such a state. However, there was an argument that the F-K state is not gauge invariant. We resolve the problem by deriving a correct gauge invariant condition and showing that the F-K state is a solution of the condition. We also discuss the relation between the asymptotic state and the asymptotic symmetry for QED.