Title : *New approaches to quantum field theory*		
First Name : Balt	**Name** : VAN REES	**Laboratory** : CPHT
Email : balt.van-rees@polytechnique.edu		
Webpage : https://www.cpht.polytechnique.fr/?q=en/node/546		
Research Area: Mathematical Physics		
Methods: theoretical physics, sometimes using numerical methods		

PhD track subject:

Quantum field theory is the mathematical language of particle physics, but at the same time it is of fundamental importance in statistical mechanics, cosmology and string theory. Quantum field theory methods are used to describe scattering processes at the large hadron collider, critical phenomena in fluids, superfluids and magnets, and also to understand quantum gravity using holographic dualities.

Traditionally computations in quantum field theory proceed through the evaluation of Feynman diagrams. This works extremely well in certain cases but becomes increasingly laborious in others, and in so-called strongly coupled theories this approach is all but hopeless.

In this project we instead return to the foundations of quantum field theory and use its basic axioms to develop and extend novel computational methods. Remarkably, in some cases the constraints that follow from these axioms turn out to be so stringent that some observables are immediately and completely determined. This so-called "bootstrap" approach has seen a resurgence in the last ten years, and numerical methods in particular have proven to be increasingly effective at constraining all sorts of physical observables. This started with the "conformal bootstrap" (lecture notes at https://arxiv.org/abs/1602.07982) but nowadays also extends to non-conformal quantum field theories with the "S-matrix bootstrap" (https://arxiv.org/abs/1607.06109 is one of the first papers). There is an ongoing collaboration with other investigators (in the US and Europe) at http://bootstrapcollaboration.com/ and many lectures and seminars can be found at its youtube channel https://www.youtube.com/channel/UCgWLG2q2275RuUJ5eNSCCFA.

The details of the thesis project remain to be filled in and can depend on the candidate's interests and skills, but I hope the above provides sufficient context. The project itself can take either a numerical, analytical, or even formal mathematical direction.

References: as above; see also the outreach articles listed at http://bootstrapcollaboration.com/