The first of the talk will be a gentle introduction to a new class of Monte Carlo algorithms that is currently getting a lot of attention in Statistics (and elsewhere), in which one replaces an intractable quantity by an unbiased estimate, and obtains nonetheless simulations from the exact target distribution. I will explain what are the mainideas behind this approach, be considering the simplest of these algorithms, namely Beaumont's (2003) GIMH. One important point is that the unbiasedness property is actually an intermediate result, towards showing that one may include the random variables generated to obtain the unbiased estimate as auxliary variables in an extended target distribution.

In the second part of the talk, I will focus on the particle Gibbs (PG) sampler, a specific instance of PMCMC (particle chain Monte Carlo algorithms), a particular class of the Monte Carlo algorithms based on auxiliary variables, in which a particle filter is used as a proposal mechanism. PG is a Markov chain algorithm which operates on the extended space of the auxiliary variables generated by a interacting particle system. In particular, it samples from the discrete variables that determines the particle genealogy. With Sumeet Singh, we managed to show that the corresponding Markov kernel converges in some sense to some limit kernel as the number of particles goes to infinity; to establish the ergodicity of the Particle Gibbs Markov kernel, for any number of particles, under certain assumptions. I will also discuss several algorithmic variations, either proposed in the literature or original. For some of these variations, we were able to prove that they strictly dominate the original algorithm in terms of Peskun ordering, while for the others, we provide counter-examples that they do not.