S4F3 Graduate Seminar Applied Probability **WS 2015/16**

Stochastic filtering & Bayesian inverse problems

Andreas Eberle Thursdays 14-16, Room 0.003

Many applied problems can be formulated as Bayesian models on function spaces. An important example is stochastic filtering where the goal is to reconstruct the trajectory of a stochastic process from a sequence of noisy observations. Here the prior is the law of a Markov chain or a diffusion process, and we are interested in the posterior distributions given the observations up to time t. These can be described by methods from stochastic analysis and approximated numerically by sequential Monte Carlo methods. In another important class of models, the prior is a Gaussian random field, i.e., a Gaussian measure on a space of functions (e.g., the law of a Brownian bridge), and the posterior is a probability measure that is absolutely continuous w.r.t. this Gaussian measure. For sampling from the posterior one relies on Markov Chain Monte Carlo methods based on Markov processes on the function space that preserve the posterior probability measure.

Participation in the seminar requires a solid background in stochastic analysis (Itō calculus for Brownian motion, Girsanov theorem). Some additional background on Gaussian measures and stochastic processes on infinite-dimensional state spaces will be provided in the seminar.

References:

a. **Stochastic filtering**

- Bain, Crisan, *Fundamentals of Stochastic Filtering,* Springer (2009)
- Papanicolaou, *Stochastic Analysis Seminar on Filtering Theory*, http://arxiv.org/abs/1406.1936
- *The Oxford handbook of nonlinear filtering*

b. **Bayesian inverse problems**

- Dashti, Stuart, *The Bayesian approach to inverse problems,* http://arxiv.org/abs/1302.6989

c. **Stochastic analysis on function spaces**

- Da Prato: *An introduction to infinite-dimensional analysis,* Springer (2006)

Prerequisites: „Introduction to Stochastic Analysis“.

Preliminary meeting 14.7.2014, 14.30 s.t., N0.007