Meshfree discretisation methods play an increasingly important role in the numerical simulation of complex processes. In particular for problems where the underlying geometry is changing or for higher dimensional problems they are more flexible than classical mesh-based methods. They are also used in combination with classical methods to form hybrid discretisation techniques.

In this talk I will discuss meshfree methods, which are based upon positive definite kernels. Typical examples comprise high order methods using radial basis functions.

I will start with a short discussion of typical applications coming from fluid-dynamics, fluid-structure interaction, image colorisation and surface reconstruction. Then, I will use the standard approach via optimal recovery to introduce kernel-based approximation methods. After that, I will discuss theoretical results such as stability and convergence orders for typical applications including the numerical solution of semi-linear parabolic problems. Finally, I will discuss new results on multiscale modelling using kernel-based methods.