

# Efficient time integration methods

## PROBLEM CLASS

Consider nonlinear evolution equations

$$u'(t) = A(t)u(t) + B(u(t)), \quad t \in (t_0, T).$$

Includes autonomous semi-linear and non-autonomous linear equations.

- Gross–Pitaevskii equations with rotation (moving frame, see logo)
- Deterministic Gray–Scott equations with creation of Turing patterns  
Stochastic Gray–Scott equations driven by fractional Gaussian fields (multiplicative noise)

## MAIN OBJECTIVES

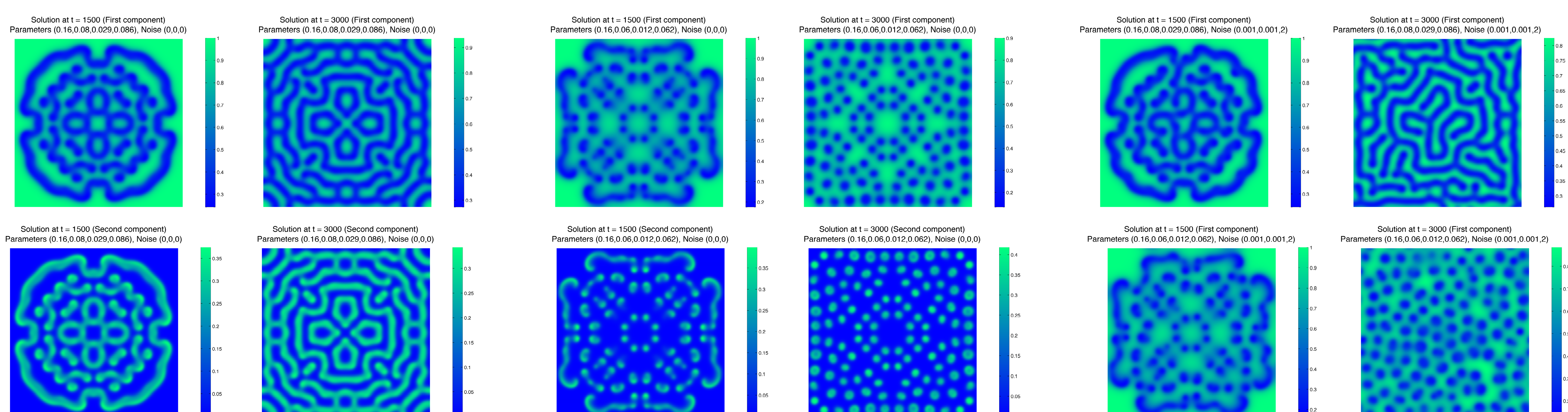
Design efficient time integration methods.

Provide rigorous stability and convergence analysis.

## APPROACH

Apply commutator-free quasi-Magnus exponential integrators, i.e., solve sequence of related autonomous equations by operator splitting methods. In autonomous case, use local error control with negligible additional cost to enhance reliability and efficiency.

## ILLUSTRATIONS (GRAY–SCOTT EQUATIONS)



Movies available at <http://techmath.uibk.ac.at/mecht/MyHomepage/Research.html>

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