# TMA4195 Mathematical Modeling

**Lecturer:**

- Espen R. Jakobsen (professor, siv.ing.)
- Reasearch:

  Non-linear PDEs, differential equations, numerics, analysis, stochastics, control theory, and mathematical finance

- More info: www.math.ntnu.no/∼erj

**Practical information:**

- wiki.math.ntnu.no/tma4195/2017h/
- Grading: Final Exam (75%), Project (25%)
- Lecture note: On the wiki (partial), and in Blackboard (complete).

  Some paper copies sold at department (IMF) office (100 NOK)

- Home work: Every week. Very important - please do it!

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**Mathematical model:**

Equation(s) describing a physical problem/phenomenon originating in science, engineering, economics, or some other area.

A good mathematical model is simple, predictive, and works for a whole range of situations.

**Mathematical modeling:**

The process by which we formulate, analyze, and solve the model:

1. selecting most important relevant quantities/variables,
2. deriving model equations – making model specific assumptions,
3. solving the model equations (simulation, approximation, exact...)
4. comparing the solutions to real data and interpreting the results,
5. revising/refining until the model describes accurately/satisfactorily the physical phenomenon and other similar phenomena.

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**Lectures based on case-studies and the following techniques:**

1. Dimensional analysis
   - give easy to obtain simple models
2. Scaling and non-dimensionalization
   - produce $O(1)$ and non-dimensional variables and equations
3. Perturbation methods:
   - produce approximate solutions of equations with small parameters
4. Simple dynamical systems (ODEs):
   - used to introduce equilibrium, stability, bifurcation; population models
5. Conservation principles:
   - direct mathematical description of fundamental laws of nature
   - conservation laws, the metod of characteristics
   - modeling with diffusion, the diffusion equation

# OBS!

# The first atomic explosion; Nevada, USA, 1945

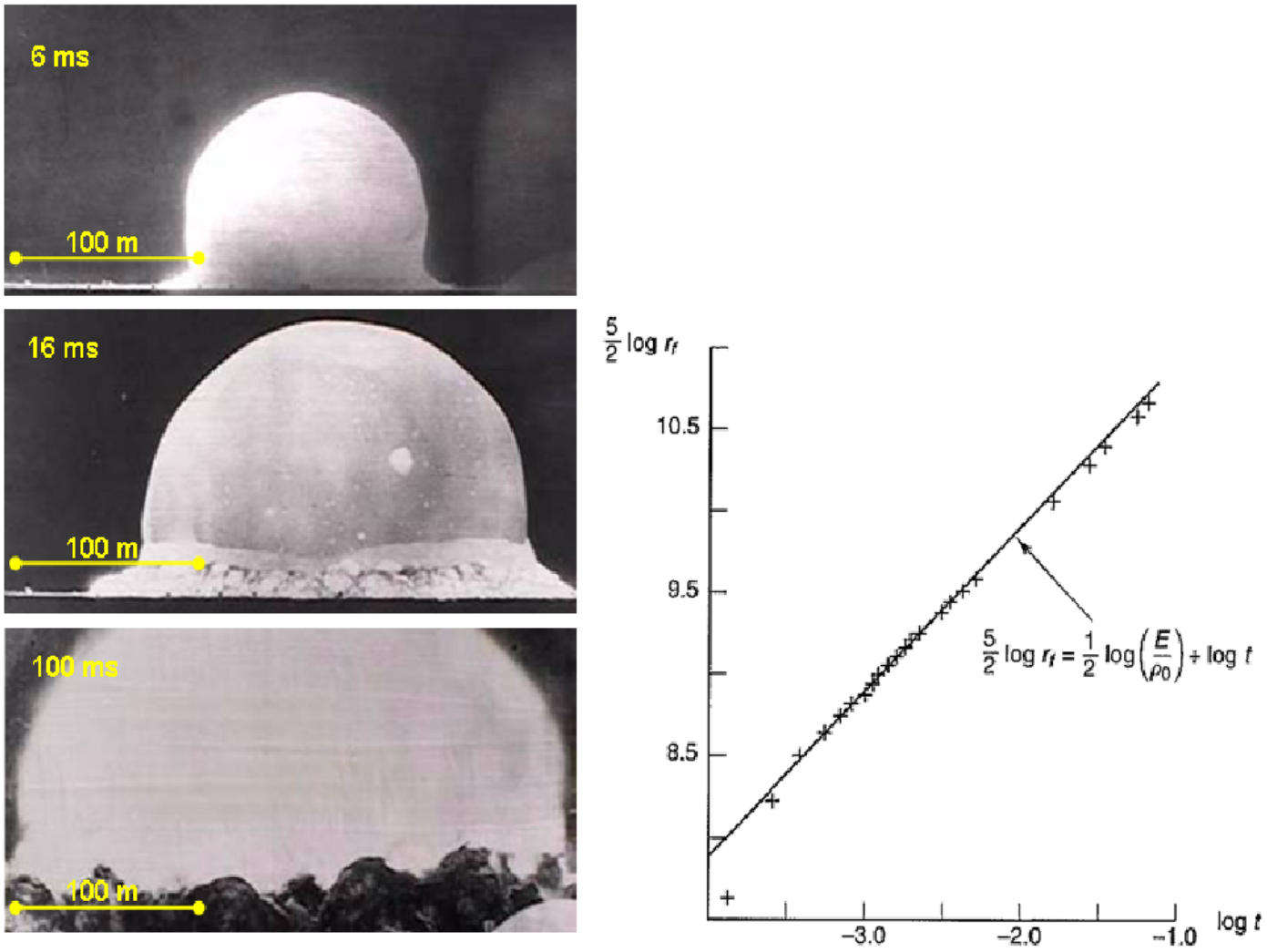


**Figure 2:** This series of images from the first atomic bomb explosjon shows a fireball growing with time. To the right is shown a copy of the figure G.I. Taylor published based on the whole sequence of images (See the book of Barenblatt, s. 47 – 50).