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Supercomputing in science

- Engineering: combustion, turbulence, fluids, materials
- Life sciences: genomics, pharmaceuticals, hemodynamics
- Geophysics: climate, weather, earthquakes, plate tectonics
- Particle physics: structure of matter
- Astrophysics/Cosmology: exoplanets, black holes, galaxy formt'n
- Software: data frameworks, community s/w

Many techniques and strategies in common, but also problems:

large dynamic range, resolution/domain size/time, parallelization

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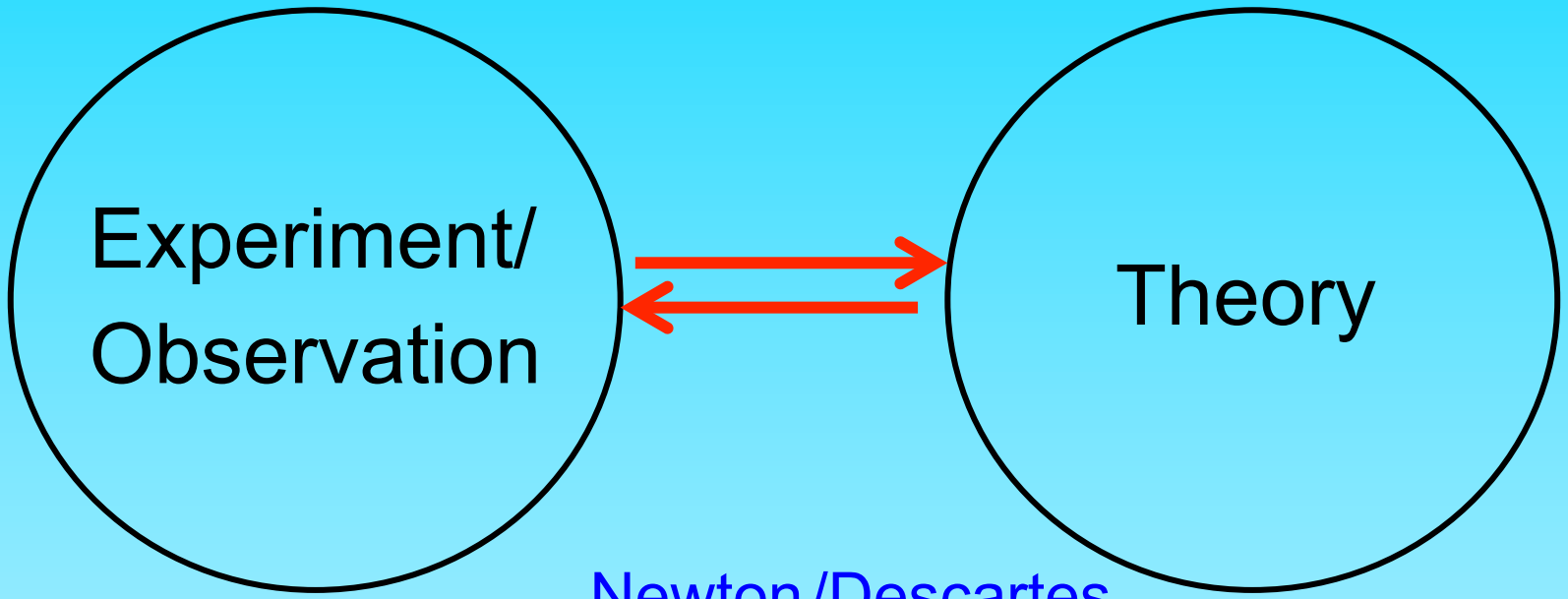
The traditional scientific method



Newton/Descartes

Limitations:

- Cannot perform experiments (climate, cosmology)
- Theory is too complex (turbulence)

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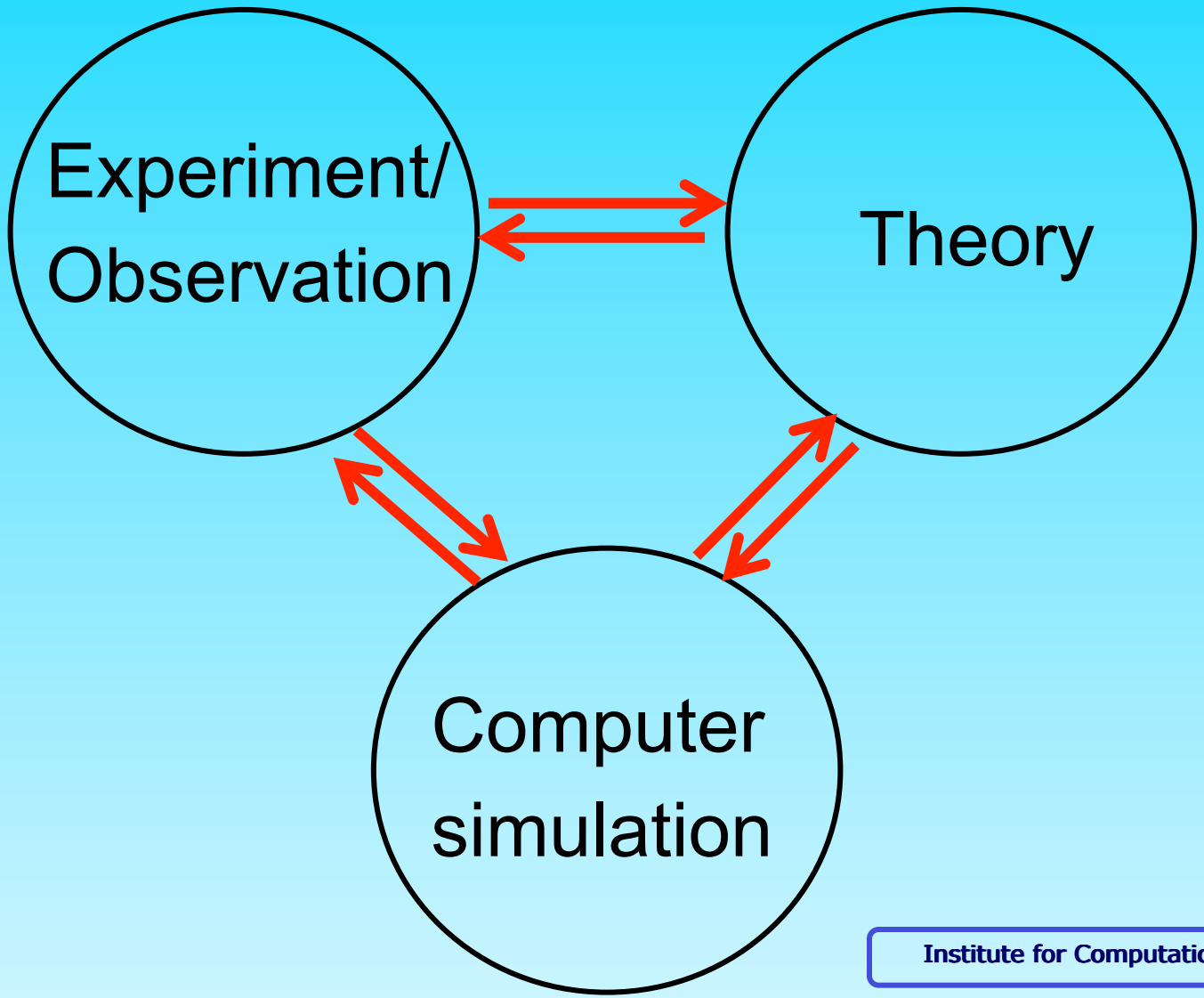
The modern scientific method in cosmology



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The modern scientific method in cosmology

Thomas Gillet

University of Durham

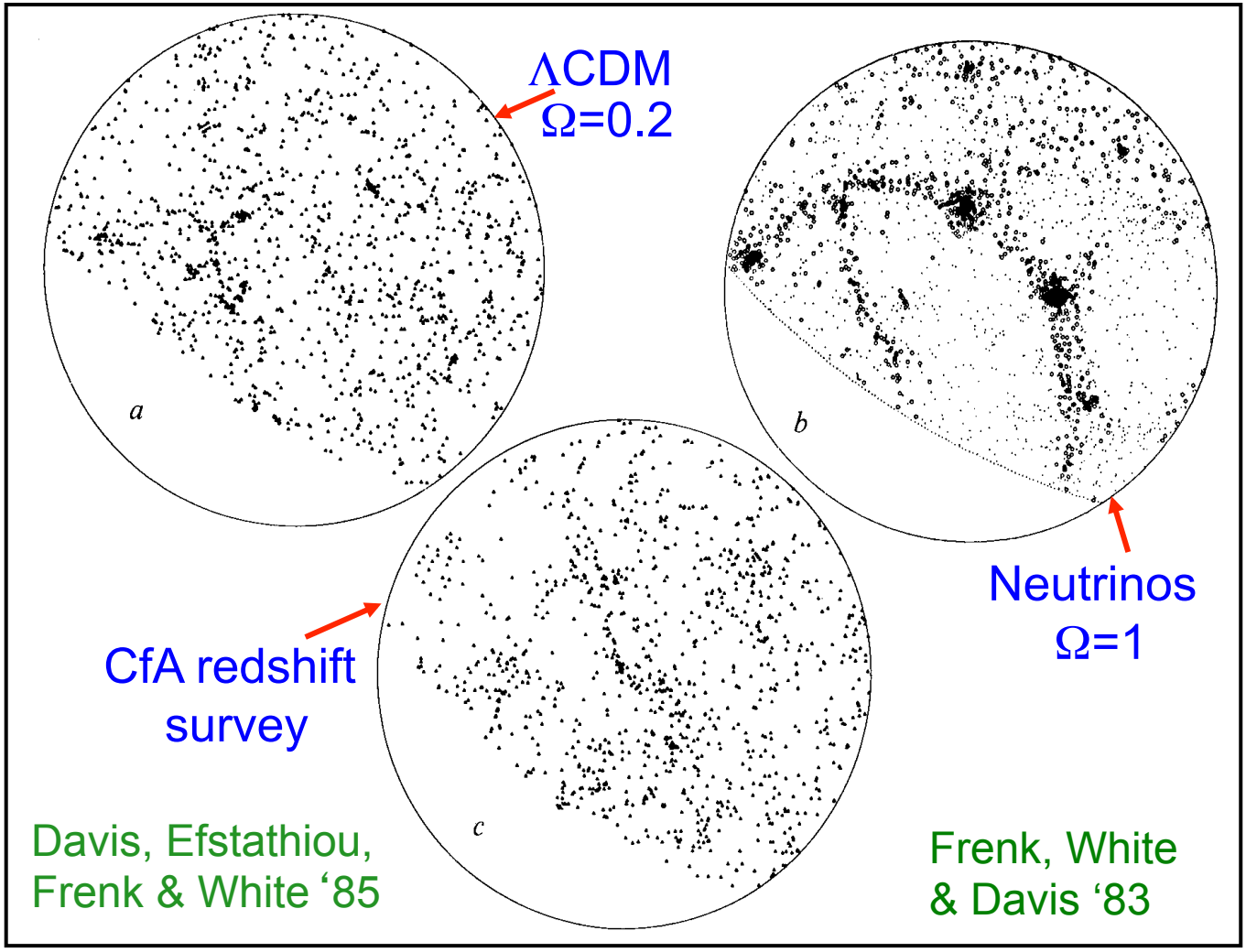
Non-baryonic dark matter cosmologies

Neutrino DM → wrong clustering

Neutrinos cannot make appreciable contribution to Ω → $m_\nu << 30$ ev

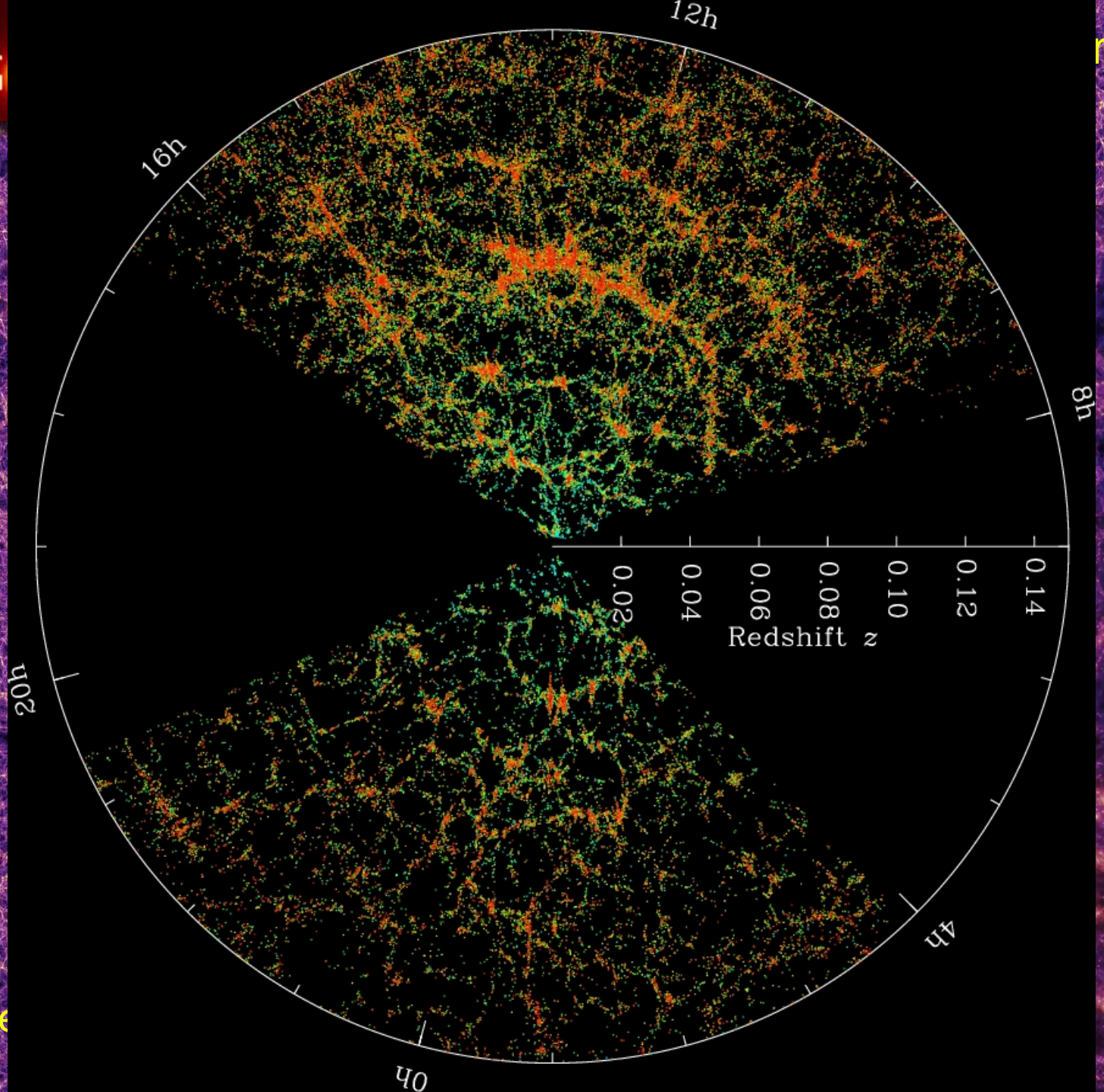
Early CDM N-body simulations gave promising results

In CDM structure forms hierarchically



VIRG

n series

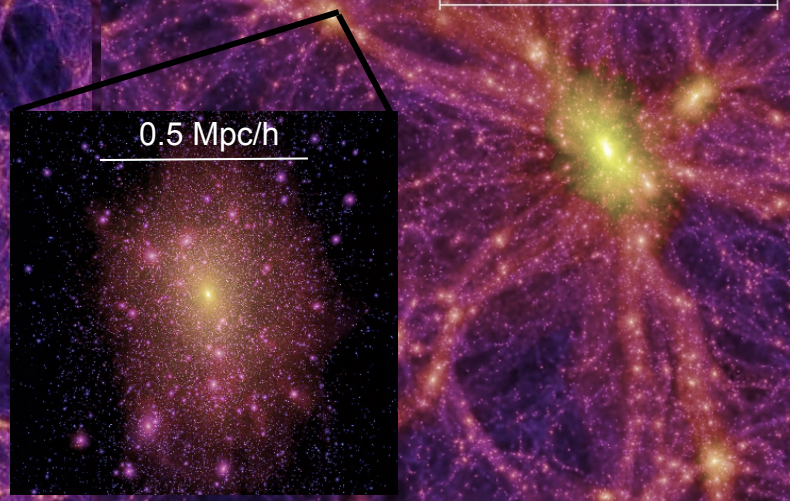


Springel e
Gao

The Millennium/Aquarius/Phoenix simulation series

Since 1980s

- Galaxy surveys ↗ x10^3
- N-body simulations ↗ x10^7



Springel et al ‘05, ’08,
Gao et al ‘11

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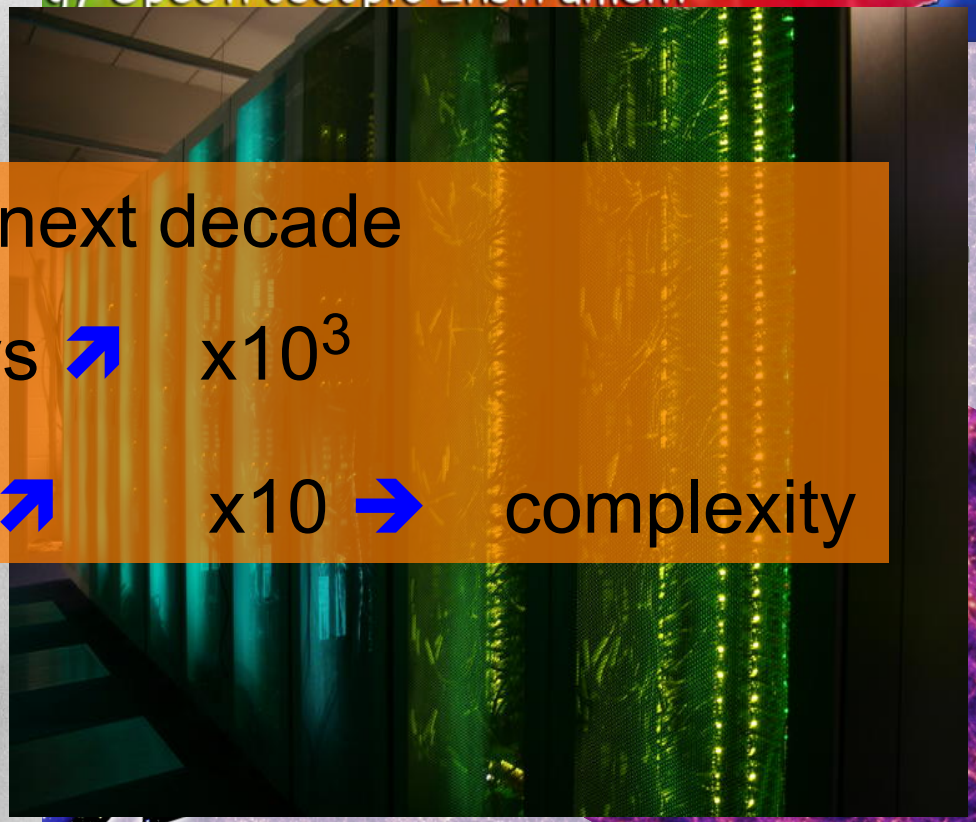
The future

Theory,experiment computing



In next decade

Galaxy surveys ↗ x10^3

Simulations ↗ x10 → complexity

Institute for Computational [illegible]ology