

Cosmic Web

Lecture course
University Groningen
October 2017

Practical Matters

Lectures: monday 09:00-11:00 ZG161
 tuesday 13:00-15:00 ZG161
 friday 11:00-13:00 Energy Academy 194

Lectures: Rien van de Weygaert
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Tracing the Cosmic Web

Workshop: 17 – 21 February 2014, Leiden, the Netherlands

Scientific Organizers

- Noam Libeskind, AIP Potsdam
- Rien van de Weygaert, U Groningen

Scientific Organizing Committee

- Yehuda Hoffman, HUJI Jerusalem
- Fransisco Kitaura, AIP Potsdam
- Sergei Shandarin, KU Lawrence
- Thierry Sousbie, IAP Paris
- Elmo Tempel, U Tartu

Topics

- Large-Scale Distribution of Matter and Galaxies
- Voids, Sheets, Filaments and Clusters
- Geometry, Topology and Multiscale Structure
- Dynamics and Evolution of the Cosmic Web
- Techniques for Characterizing Weblike Patterns
- Galaxy Formation and the Cosmic Web

The Lorentz Center is an international center in the sciences. Its aim is to organize workshops for scientists in an atmosphere that fosters collaborative work, discussions and interactions. For registration see: www.lorentzcenter.nl

Galaxies, intergalactic gas and dark matter aggregate in a complex network, known as the cosmic web. Image: R. Kashlauer, O. Hahn, T. Abel. Processing: M. Bos. Poster design: supanovva Studios. NL



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IAU Symposium 308

THE ZELDOVICH UNIVERSE

GENESIS AND GROWTH OF THE COSMIC WEB

SOC

Sergei Shandarin
Rien van de Weygaert
Rashid Sunyaev
Jaan Einasto
Alexei Starobinsky
Igor Karachentsev
Bernard Jones
Dick Bond
Alex Szalay
Carlos Frenk
Pirin Erdogdu
Adi Nusser
Nelson Padilla
Varun Sahni
Joss Bland-Hawthorn
Tom Jarrett
J.P. Ying
Jounghun Lee

LOC

Enn Saar
Antti Tamm
Elmo Tempel
Jaan Einasto

Tallinn, Estonia

June 23-28, 2014

www.iau-zeldovich.org



Exam

1. Presentation/Lecture 100%
+ accompanying report (10-15 pages)

Special Topic

Topics/Agenda

- Review/overview Cosmic Web
- Simulations of cosmic structure formation
 - cosmic web characteristics & evolution
- Dynamics:
 - Basic Gravitational Instability theory
 - Lagrangian perturbation theory
 - Zeldovich theory
 - Adhesion approximation
- Galaxy Surveys
 - cosmic web detection methods
 - reconstruction methods: + constrained random fields
+ Bayesian inference methods
- Phase-Space Dynamics
 - phase space dynamics
 - singularities & caustic skeleton
- Cosmic Web probes
 - Galaxy surveys
 - Cosmic Flows & Anisotropic Inflow
 - Gaseous Cosmic Web: Ly α forest
 - Gaseous Cosmic Web: Sunyaev-Zeldovich
 - Dark Matter Web: Gravitational Lensing

Topics/Agenda

- Cosmic Web Analysis
 - cosmic web classification & detection methods
 - reconstruction methods: + constrained random fields
+ Bayesian inference methods
- Voids and the Void Evolution
- Hierarchical Structure Formation
 - excursion set theory
 - cosmic web theory
 - hierarchical void evolution

Literature

- **Clusters and the Theory of the Cosmic Web**
R. van de Weygaert & J.R. Bond, 2008, Springer
(Mexico summerschool lecture notes)
- **Cosmic Web: Observations and Morphology**
R. van de Weygaert & J.R. Bond, 2008, Springer
(Mexico summerschool lecture notes)
- **The Zeldovich Universe:
Genesis and Growth of the Cosmic Web**
R. van de Weygaert, S. Shandarin, E. Saar, J. Einasto
(proceedings IAU308, 2016, Cambridge Univ. Press)
- **Research papers and reviews on relevant topics**

Literature

- **Cosmological Physics**
J. Peacock; Cambridge Univ. Press, 1998
- **Large Scale Structure of the Universe**
P.J.E. Peebles, Princeton Univ. Press, 1981
The Classic Book, defining the field !!!!!!!!!!!!!
- **Precision Cosmology**
B.J.T. Jones; Cambr. Univ. Press, 2017
the new classic, advanced cosmology book
- **Cosmology**
S. Weinberg; Oxford Univ. Press, 2008
Impressive book, covering most of relevant cosmological topics, including structure formation, inflation theory, origin perturbations, CMB
- **Galaxy Formation**
M. Longair; Springer, A&A Library, 2nd ed., 2008
Good overview of structure and galaxy formation
- **Galaxy Formation and Evolution**
H.J. Mo, F. van den Bosch, S.D.M. White, Cambridge Univ. Press, 2010
Most up to date book on cosmic structure formation

Literature

- **A Pan-Chromatic View of Clusters of Galaxies and the Large-Scale Structure**
M. Plionis, O. Lopez-Cruz, D. Hughes, eds., Lect. Notes in Physics 720, Springer, 2008
Very useful reviews on in particular cluster physics.
Two chapters part of course material (Van de Weygaert & Bond 2008a, 2008b)
- **How did the First Stars and Galaxies Form**
A. Loeb, Princeton Univ. Press, 2010
beautiful expose on the first stages of structure and galaxy formation
- **the Cosmic Microwave Background**
R. Durrer, Cambridge Univ. Press, 2008
best textbook on the physics of the CMB
- **Introduction to Cosmology**
B. Ryden, Addison-Wesley, 2003
Cambridge Univ. Press, 2016 (2nd ed.)
good reference book on basic cosmology
- **Bayesian Large-scale Structure Inference and Cosmic Web Analysis**
F. Leclercq, PhD thesis, IAP, 2015
one of the very best and impressive PhD theses in cosmology in the last decade,
very clear and transparent discussion and explanations of Bayesian inference techniques