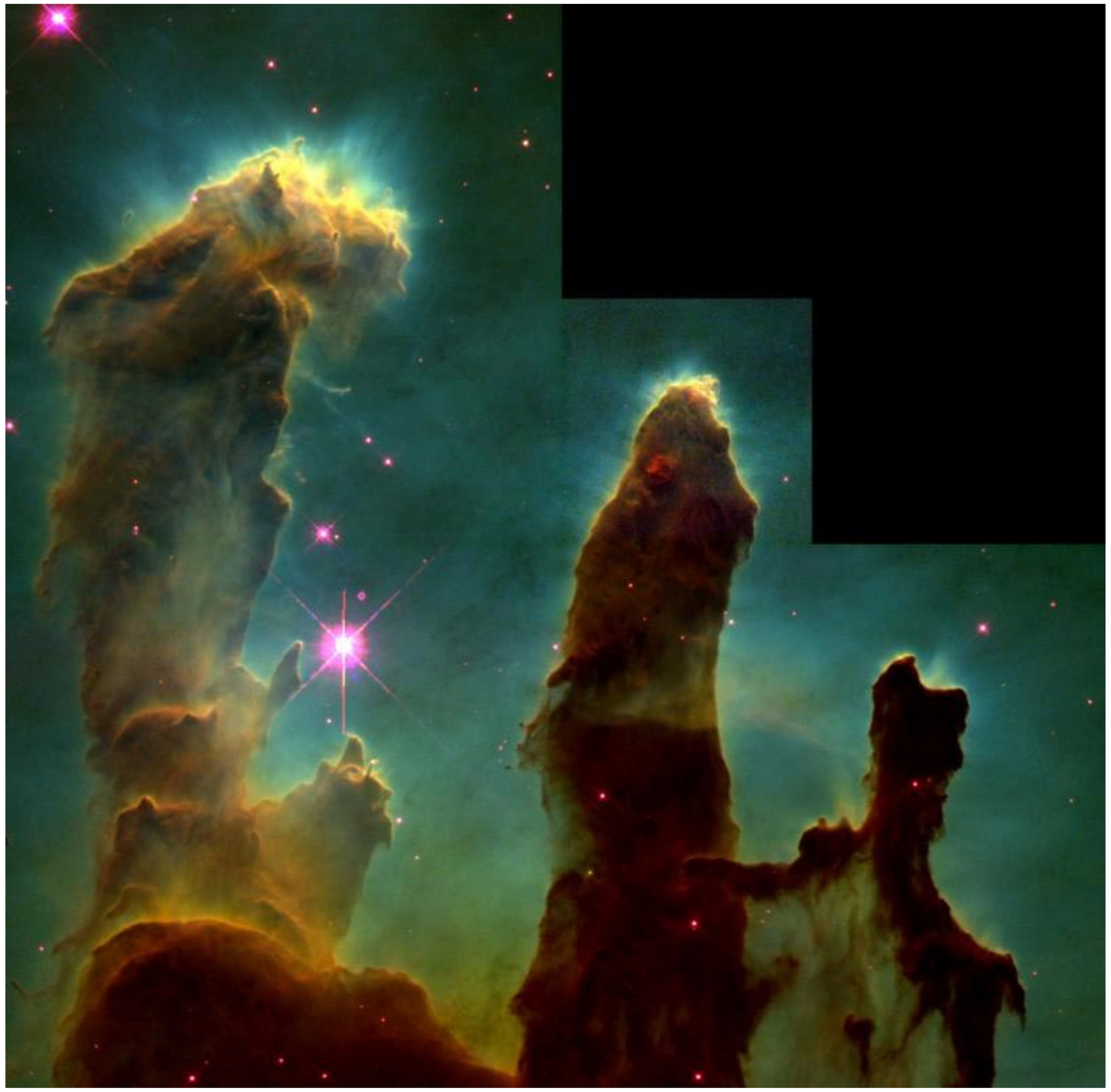
C1 Astrophysics

Course co-ordinator: Julien Devriendt jeg@astro.ox.ac.uk

- C1 offers a total of ~40 lectures on five themes covering a broad range of topics in contemporary astrophysics.
- Each theme takes off from the third-year courses and reaches a point where topics of current active research can be understood.
- The course uses special relativity, classical mechanics and GR, electrodynamics, quantum mechanics and statistical mechanics.

- Radiative processes in Astrophysics
- High-Energy Astrophysics
- Advanced Stellar Astrophysics and Galaxies
- Cosmology

Radiative Processes in Astrophysics



The Eagle Nebula star-forming region as seen by HST

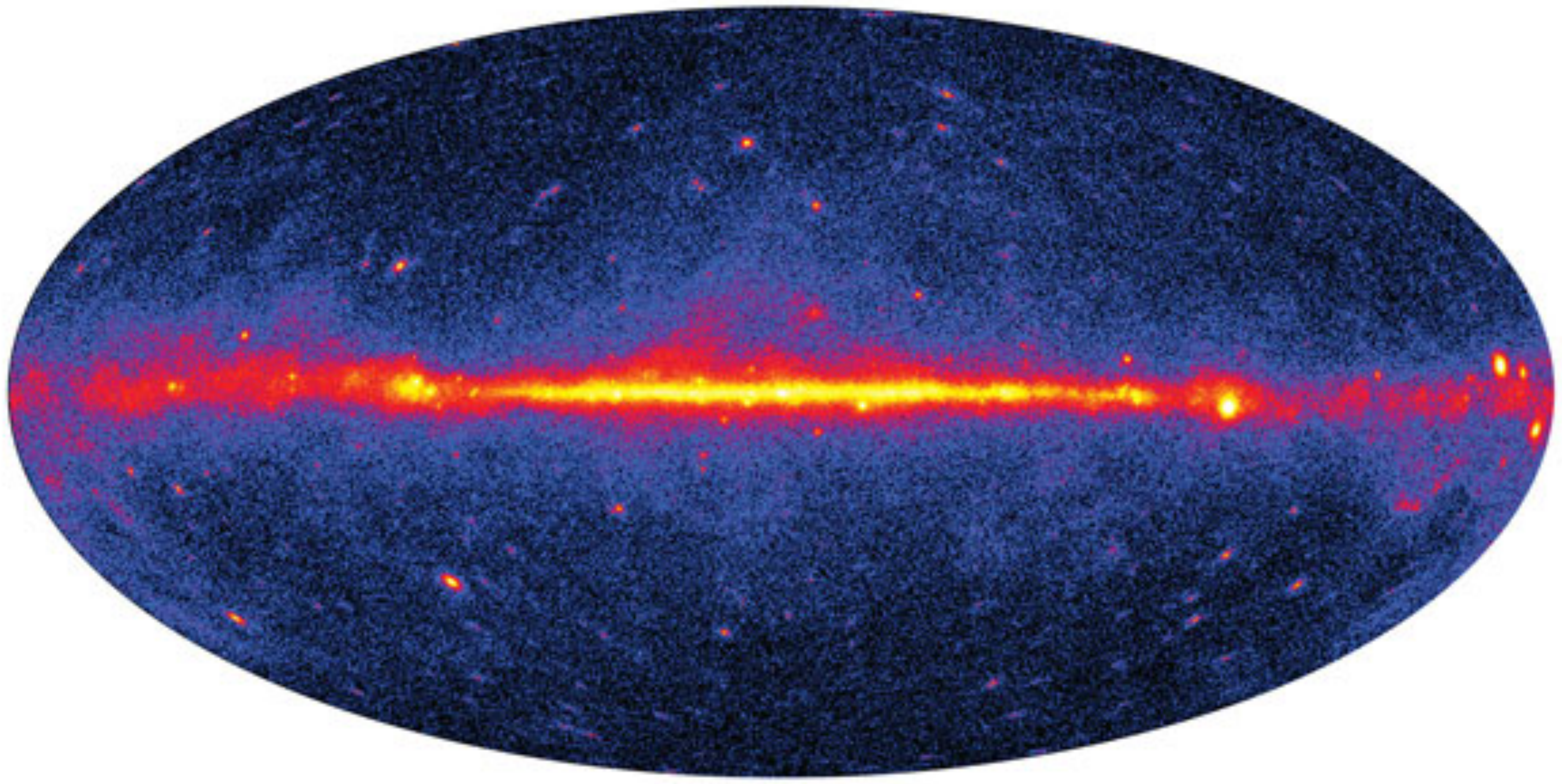
In radiative processes part of the course, we learn many of the core techniques of professional astronomy – how to turn all those pretty pictures into physics!

We learn how to use spectroscopy to measure the extreme physical properties of material in deep interstellar space – high temperatures and low densities. Transitions forbidden under normal lab conditions often play a crucial role.

We learn how emission and absorption lines are formed in stars and nebulae and how interstellar dust affects the observed spectrum of background objects – and how to correct for it.

Finally we use relativity, electrodynamics and statistical mechanics to investigate the interaction of photons with high-energy particles via synchrotron, inverse-Compton and Bremsstrahlung processes .

High-Energy Astrophysics



Left: The radio sky at 20cm (photon energy 10^{-6} eV). Right: Gamma-ray sky mapped by the *Fermi* satellite at ~100 GeV. The same extragalactic sources are seen in both images!

Major Option C1 Astrophysics

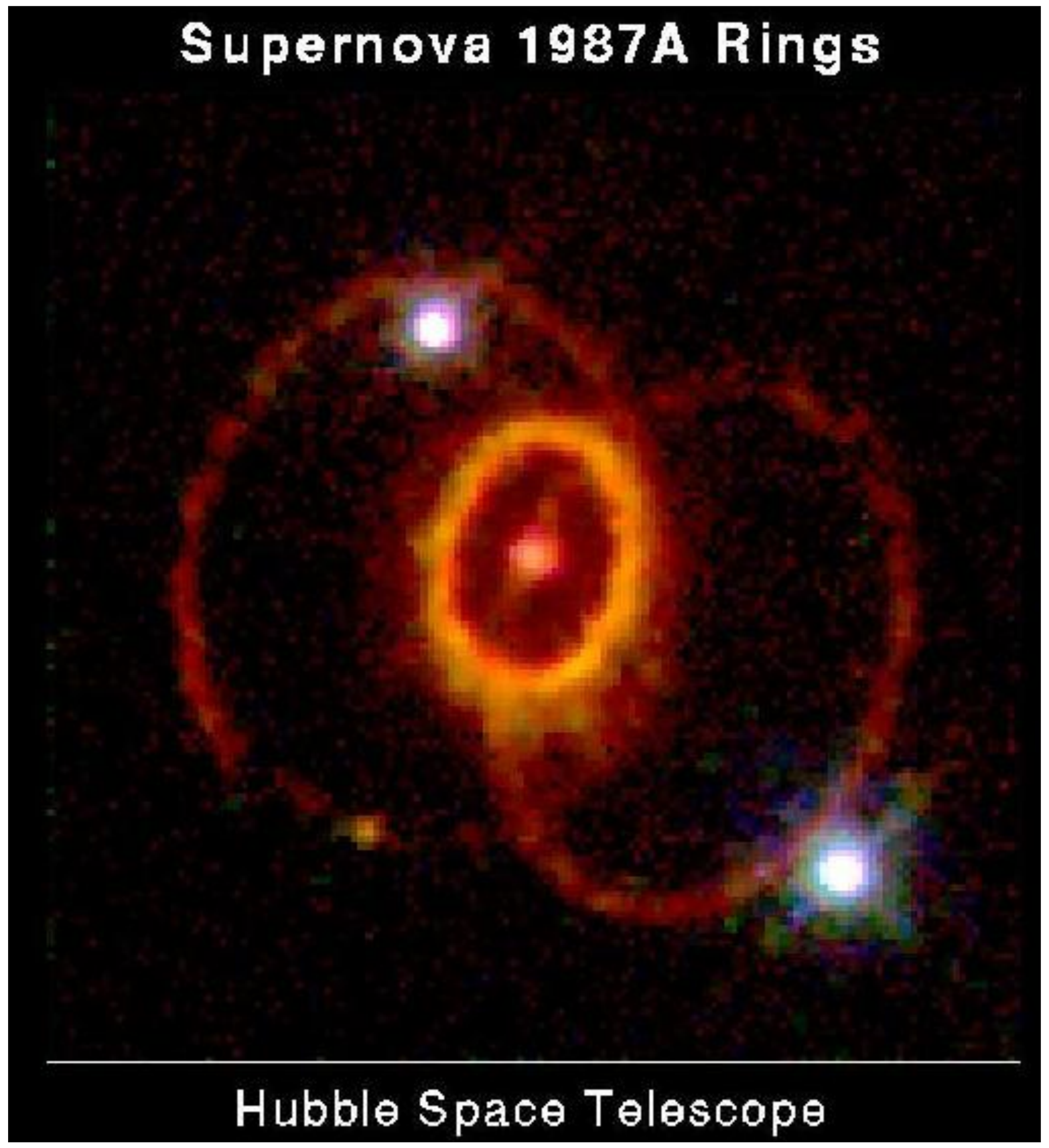
In high-energy astrophysics we study some of the most extreme phenomena in the Universe – active galaxy jets, supernovae, accretion onto black holes, and the high-temperature intergalactic medium.

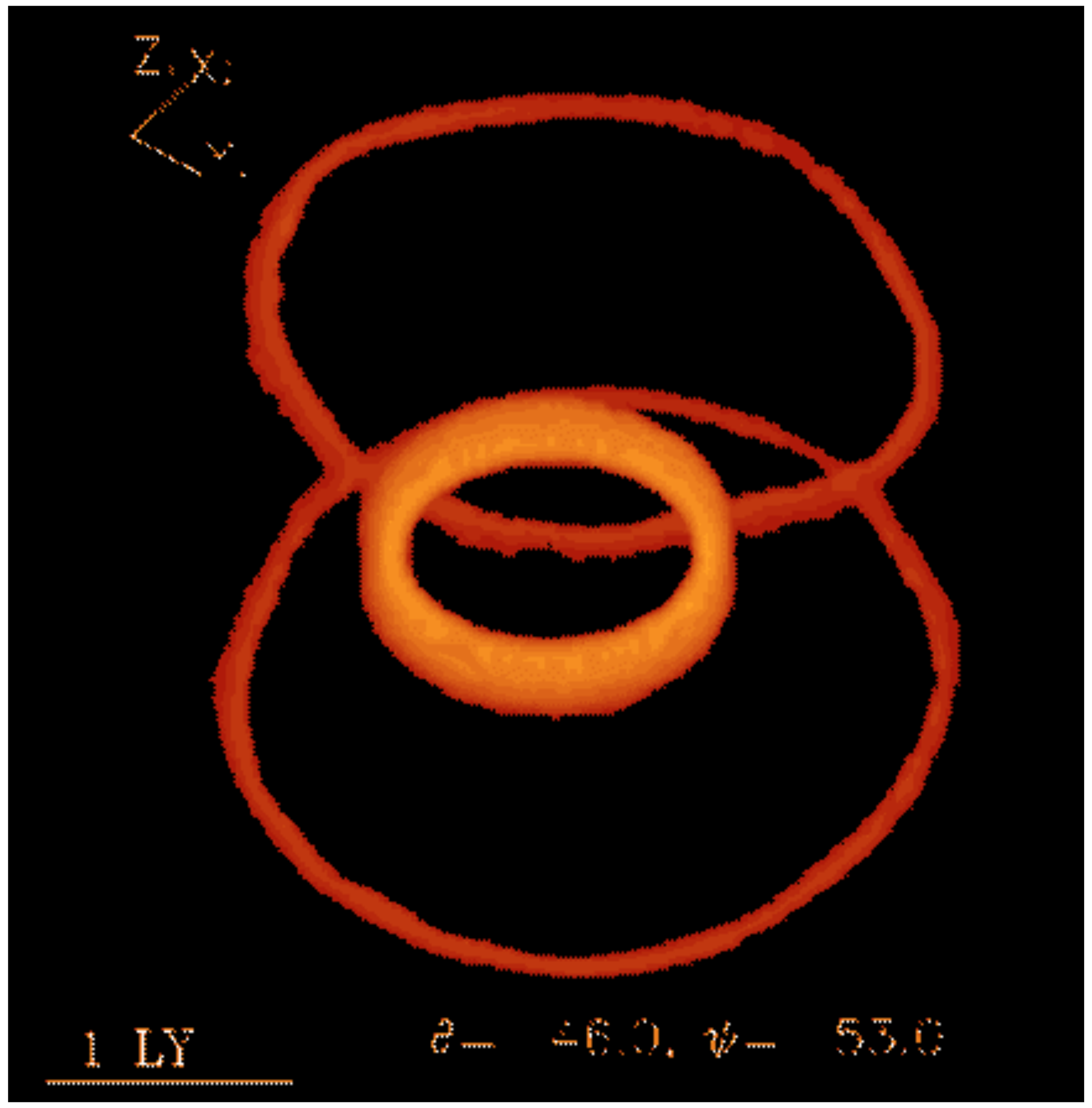
We study the fluid dynamics of strong shocks to investigate the acceleration of particles to relativistic energies.

We investigate the physics of relativistic jets from accreting black holes and their profound influence on the formation of galaxies over cosmic time, and the interaction between intergalactic gas and the Cosmic Microwave Background, which in turn allows us to measure some of the cosmological parameters.

Finally we study the detection of high-energy particles and photons from the ground via Cherenkov radiation.

Advanced Stellar Astrophysics & Galaxies





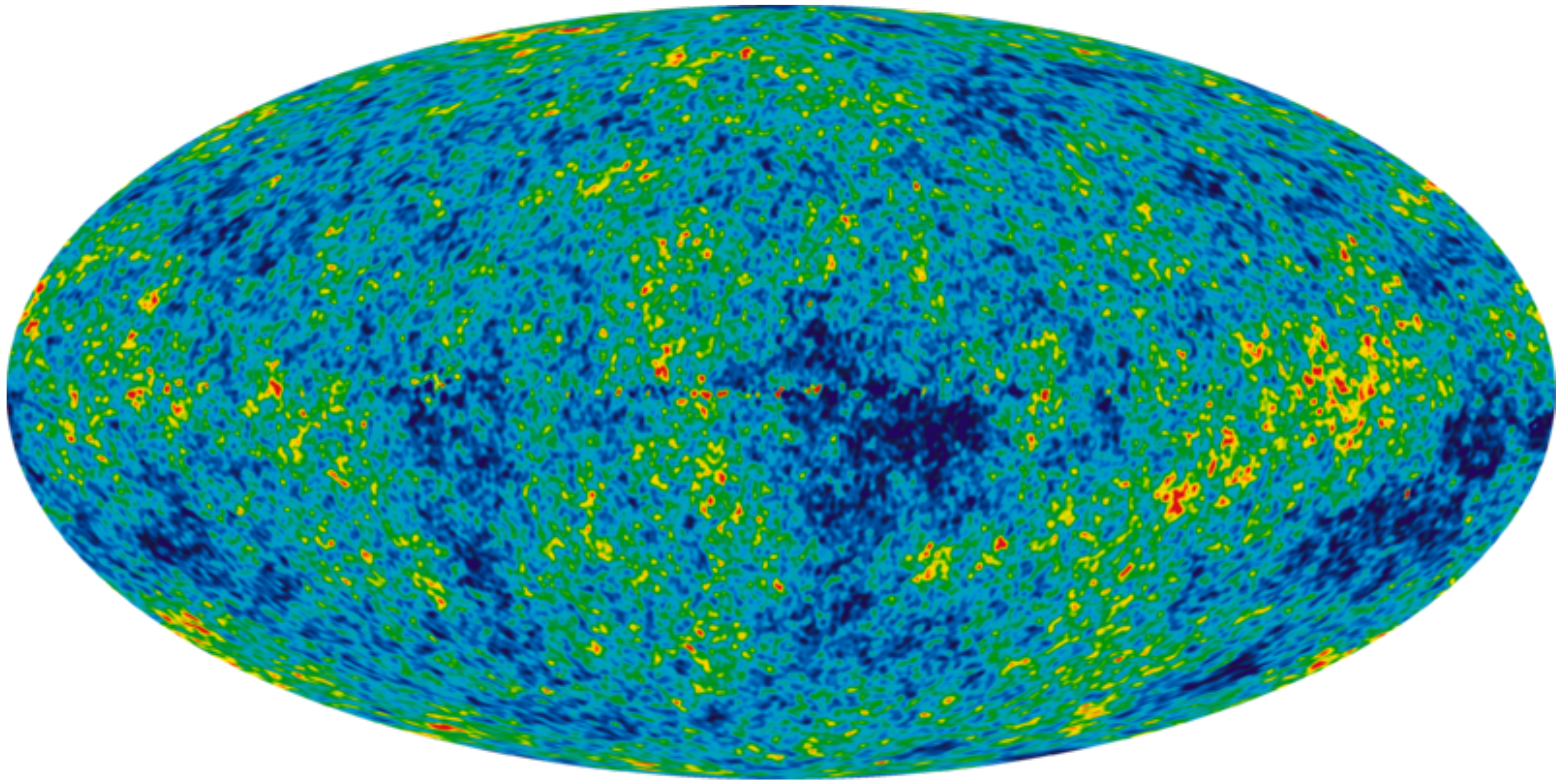
Left: Rings around supernova 1987A observed by HST. Right: model of the ring nebula demonstrating that the progenitor of SN1987A was likely a massive binary system in a common envelope.

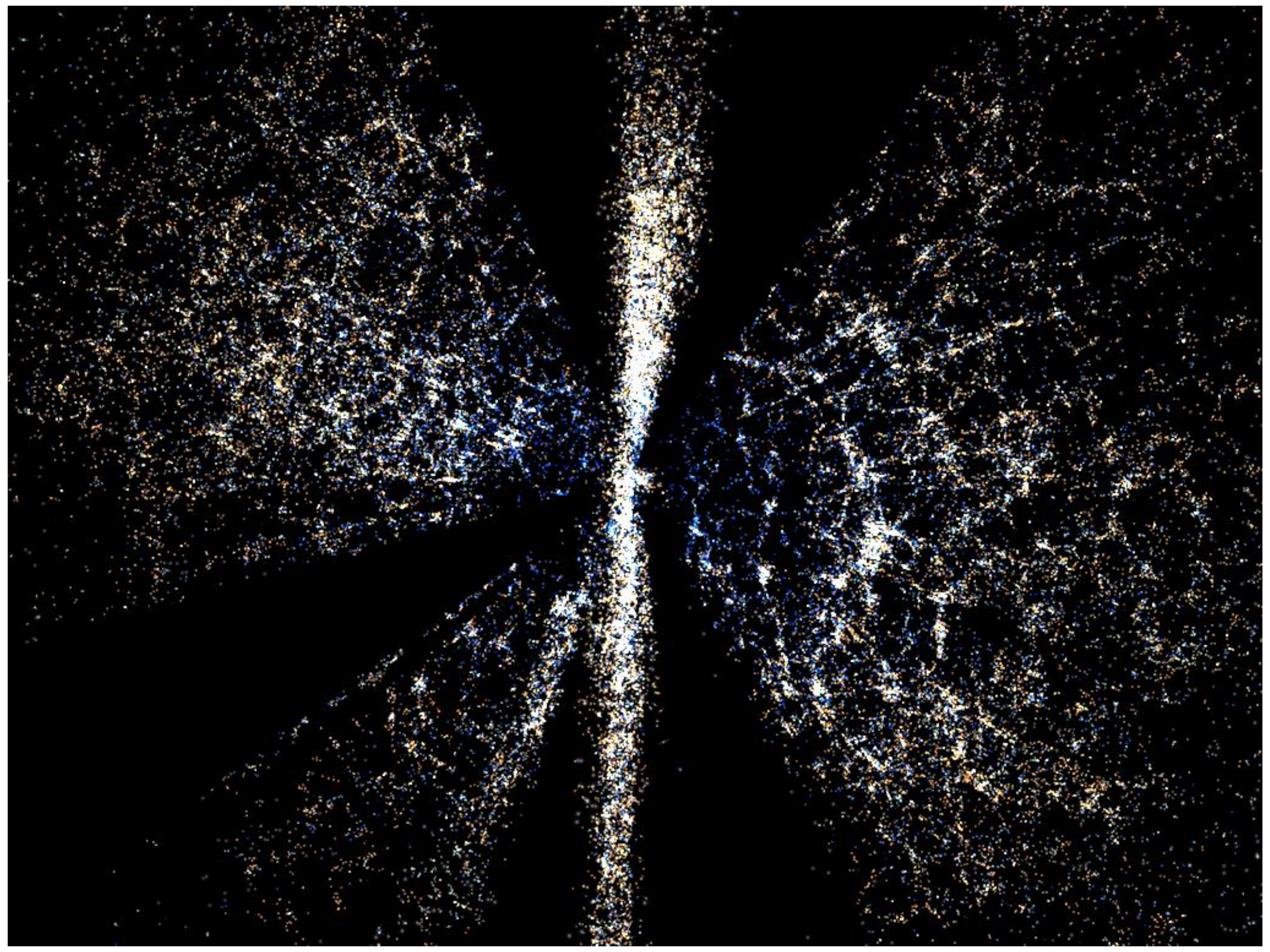
Major Option C1 Astrophysics

In advanced stellar astrophysics and galaxies we study the evolution of stars from the very early stages – star formation from interstellar clouds, including the formation of the first generations of stars in the Universe – to the latest stages of stellar evolution: novae, and supernovae.

We study how stellar populations can be used to probe the physical properties of galaxies, their assembly (galactic archeolology) and formation as well as the mechanisms driving their evolution throughout cosmic ages, their dependence on environment and build up evidence for the existence of dark matter.

Cosmology





Left: Density fluctuations of 1 part in 10^5 when the universe was 300,000 years old as mapped by the Planck satellite. Right: filamentary distribution of galaxies in the local universe at the present epoch as mapped by the Sloan Digital Sky Survey.

The section on Cosmology builds on B5 General Relativity & Cosmology. We take the expanding universe Friedmann models & investigate the amplification of density fluctuations as the Universe grows.

These growing fluctuations are the seeds for modern day structure from galaxies to superclusters and encode information about the ingredients of the Universe – baryons, dark matter and dark energy.

We study how observations of the Cosmic Microwave Background and redshift surveys of galaxies may be used to measure the relative proportions of these components.

In Conclusion

There is no pre-requisite for C1 other than the relevant core lectures but we do recommend the you study “Stars and Galaxies” short option notes over summer as background reading.

Astrophysics always offers a large range of M.Phys projects, from technical work in radio and optical astronomy through observational work with the Wetton telescope to numerical simulations, modelling and theory. We always ensure that every C1 student who wishes to do an astrophysics M.Phys. project is catered for.

Astrophysics is a very sociable department! C1 students are encouraged to attend our Monday colloquia during term which are followed by coffee, tea & cookies and dinner with the speaker at a nearby pub.

If you wish to know more please email jeg@astro.ox.ac.uk with questions or to arrange to have a chat. Finally, for more detail, see the course web page at

http://www-astro.physics.ox.ac.uk/~astroc1/C1_Home.html