HORIZON 2020

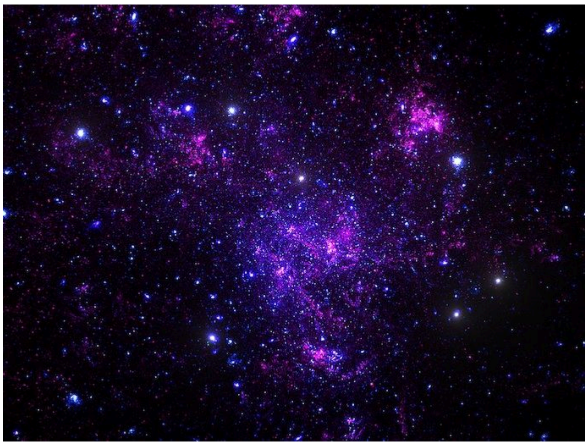
The origin of the Galactic magnetic field

Results in Brief

Understanding interstellar magnetic fields to learn secrets of the galaxies

Solving this tricky problem at the heart of galactic physics could help reveal the origins of galaxies, planets and life itself.

SPACE



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Magnetic fields lie at the heart of almost every question about the evolution of galaxies. Studying them can reveal many answers about galactic development, such as the rate at which stars formed. Indirectly, this knowledge can even shine a new light on the emergence of planets and life.

Yet it is impossible to measure the interstellar magnetic field directly, which makes the task incredibly challenging. Magnetic fields in space can only be calculated through their interaction with the background radiation found between planets and stars.

As this interaction is quite weak, it can lead to large uncertainties in the measurements. What's more, the magnetic field is a vector – it has both a strength and a direction in space.

"No observational method known so far can give us both these characteristics for the same area of space," explains Eva Ntormousi, an astrophysicist at the Forth Institute of Astrophysics and lead researcher on the ORIGAMI project.

The ORIGAMI project was set up to fill in these knowledge gaps using complex and comprehensive numerical modelling. “Our simulations trace the co-evolution of the magnetic field with the galaxy, offering a self-consistent picture of the dynamics,” says Ntormousi, whose research was undertaken with the support of the Marie Skłodowska-Curie programme.

Dynamic modelling

ORIGAMI is an ambitious project developing the first simulations to include all the core processes of galactic evolution. These advanced models include vital interstellar components, such as gas and the kinetic and thermal energy that is emitted from stars as they implode as supernovae upon death.

To gain the most successful modelling of galactic magnetic field evolution, the team started with a small magnetic field as an initial state for the model and monitored its evolution in tandem with the galaxy.

The most important result of the project was the emergence of a dynamo (a transfer of mechanical energy into magnetic energy) in Milky Way-like galaxy simulations. The resulting magnetic field, after 2 billion years of galactic evolution, is composed of an ordered and a chaotic component, much like the Milky Way’s magnetic field.

“Magnetic fields measured in the interstellar medium of galaxies are over a billion times stronger than what our theories predict for the early Universe. The main idea is that the evolution of the galaxy itself is a driver for amplifying the magnetic field,” explains Ntormousi.

Stargazing

The research will continue even past the project end date. The team is now expanding the study to include galaxies of different masses, which will help them understand the role of dynamics in the emergence of a dynamo.

The current project being run at the Scuola Normale Superiore is to investigate how magnetic fields emerged when the Universe was very young, during a period known as the Epoch of Reionisation.

“The origins of magnetism in the Universe are one of the greatest mysteries in modern physics. Since galaxies are the laboratories for magnetic field evolution, understanding the galactic magnetic field brings us one step closer to understanding the origin of one of Nature’s fundamental forces,” says Ntormousi.

Keywords

ORIGAMI magnetic galactic fields space dynamo evolution

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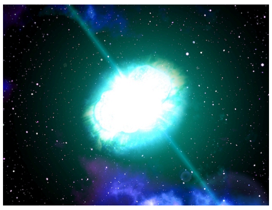

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Project Information

ORIGAMI

Grant agreement ID: 749073

Project website

DOI
10.3030/749073

Project closed

EC signature date
7 March 2017

Start date
1 June 2017

End date
29 November 2019

Funded under
EXCELLENT SCIENCE - Marie Skłodowska-Curie Actions

Total cost
€ 152 653,20

EU contribution
€ 152 653,20

Coordinated by
IDRYMA TECHNOLOGIAS KAI EREVNAS
Greece

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