UK-led robotic sky scanner reveals its first galactic fingerprint

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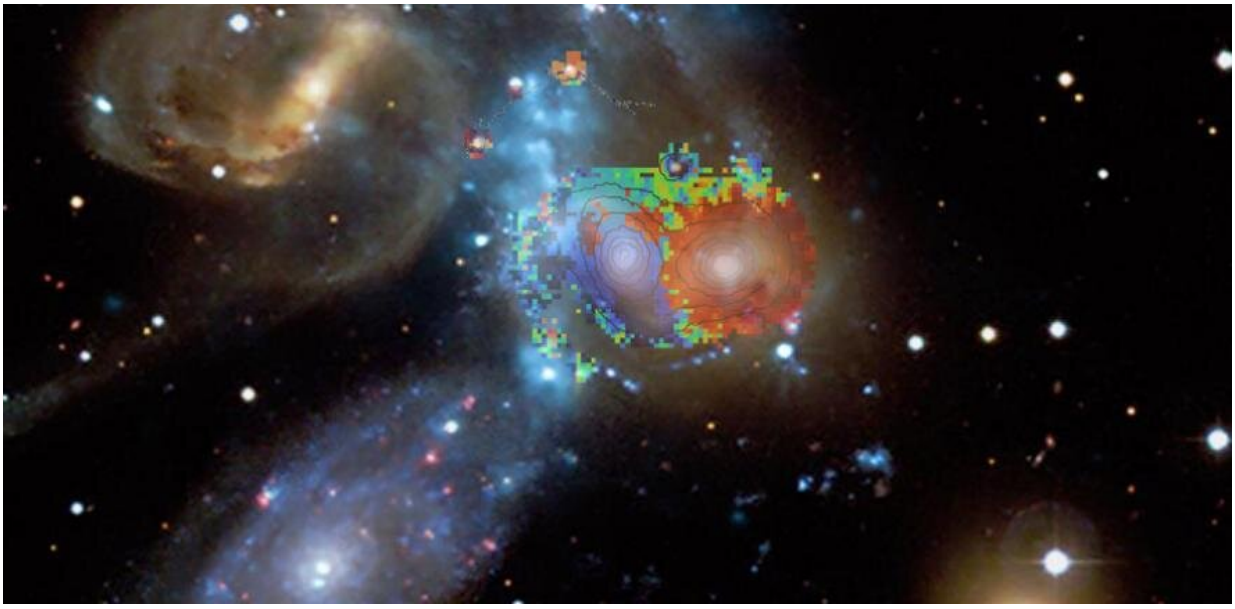

Blue, green and red colours, according to velocities derived from the WEAVE spectra, are overlaid on a composite image of Stephan's Quintet, which features galaxy star light (CFH telescope), and X-ray emission of hot gas (blue vertical band, Chandra X-ray Credit: ING

A major telescope upgrade has peered through to the distant universe to reveal the spectra of a pair of galaxies 280 million light years away from Earth.

The spectra provide a first glimpse of the sky from the WHT Enhanced

Area Velocity Explorer (WEAVE)—a unique upgrade to the William Herschel Telescope (WHT) in La Palma on the Canary Islands.

After its integration into the WHT last year, WEAVE has now begun its on-sky commissioning phase, ready to reveal more than 12 million spectra of stars and galaxies over the next five years.

The Science and Technology Facilities Council (STFC) is one of the key partners in the operation of the WHT. Data processing, analysis and archiving for WEAVE is led by astronomers from the University of Cambridge, with support from the IAC in Spain and INAF in Italy.

Understanding the universe through spectra

Spectroscopy is an essential element in an astronomer's toolbox. Analyzing light detected with a telescope reveals useful scientific information, such as the speed of the object observed, the atoms it is made of and its temperature.

If an image tells us what an astronomical object looks like, its spectrum tells us what it is.

First galactic spectra with WEAVE

A galactic spectrum is the combination of spectra from the millions of stars in an observed galaxy. Studying the features of a galaxy spectrum allows astronomers to understand what types of stars the galaxy contains, and the relative abundances of each type of star. This tells us about how the galaxy formed and changed over time.

First-light observations with WEAVE were carried out with the large integral-field unit (LIFU) fiber bundle, one of WEAVE's three fiber

systems. The team observed the heart of the galaxy group Stephan's Quintet, a group of five interacting galaxies.

The instrument was aimed at NGC 7318a and NGC 7318b, a pair of galaxies at the center of a major galaxy collision 280 million light-years from Earth in the constellation Pegasus.

"The wealth of complexity revealed in this way by a single detailed observation of this pair of nearby galaxies provides insights into the interpretation of the many millions of spectra that WEAVE will obtain from galaxies in the distant universe and provides an excellent illustration of the power and flexibility of the WEAVE facility," said Professor Gavin Dalton from the University of Oxford.

The WEAVE LIFU (large integral-field unit) measures separate spectra for 547 different regions in and around the two galaxies, recording the colors of their light from the ultraviolet to the near-infrared.

These spectra reveal the motions of stars and gas, the chemical composition of the stars, the temperatures and densities of the gas clouds, and more. This data will help astronomers learn how galaxy collisions transform the galaxies in the group.

"Without even breaking a sweat, WEAVE has provided us with an unprecedented glimpse into the dance of this enigmatic group of galaxies," said Dr. David Murphy from Cambridge's Institute of Astronomy, lead of spectroscopic pipeline development for WEAVE.

"This exciting initial release provides a snapshot of the various ways the instrument can provide insights into the universe. Coupled with our rapid-response data-processing pipelines, WEAVE will advance cutting-edge research ranging from the complex chemical fingerprint of our galactic neighborhood to the very structure and fabric of our universe."

"Our advanced analysis pipeline consists of a chain of more than 20 state-of-art modules developed to analyze a wide range of astronomical targets, from newly born hot stars to quasars," said Dr. Alireza Molaeinezhad from Cambridge's Institute of Astronomy, Lead developer of the Advanced Processing System.

"Using this pipeline on the phenomenal first-light data is like wearing 3D-glasses to watch the cosmic dance of galaxies in this system."

Eight surveys using WEAVE

In the coming five years, the ING (Isaac Newton Group of Telescopes) will assign 70% of the time available on the WHT to eight major surveys with WEAVE, selected out of those proposed by the astronomical communities of the partner countries. All these surveys require spectra of up to millions of individual stars and galaxies, a goal now obtainable thanks to WEAVE's ability to observe almost 1,000 objects at a time.

More than 500 astronomers from across Europe have organized these eight surveys, covering studies of stellar evolution, Milky Way science, galaxy evolution and cosmology. WEAVE will study galaxies near and far to learn the history of their growth, and will obtain millions of spectra of stars in the Milky Way.

"This first light event is a milestone for both the international and U.K. astronomy communities: WEAVE will provide spectra of millions of stars and galaxies over the next five years," said Professor Mark Thomson, STFC Executive Chair.

"After 10 years in development, WEAVE will now finally offer astronomers a new eye to the sky to help them answer questions such as what is dark matter and how did stars form in distant galaxies?"

"These wonderful first light images demonstrate the power of WEAVE to unravel the intricate chemo-dynamical processes at work in this galaxy system," said Dr. Nicholas Walton from the Institute of Astronomy and lead of the WEAVE data analysis system development team.

"The analysis of this data, from one of the many observational modes of WEAVE, has used our state-of-the-art science pipelines. We are now ready to handle the nightly data from WEAVE as it embarks on its main science surveys."

Provided by University of Cambridge