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## Gigantic storms sweep gas from entire galaxies

09 May 2011

### **New findings from the Herschel space observatory**

The European Space Agency's Herschel infrared space observatory has detected huge clouds of molecular gas streaming away from the centres of galaxies. Some of them have wind speeds of more than 1000 kilometres per second – about ten thousand times greater than hurricanes here on Earth. The storms were recorded with the Photodetector Array Camera and Spectrometer (PACS) instrument, developed under the leadership of the Max-Planck Institute for Extraterrestrial Physics (Max-Planck-Institut für extraterrestrische Physik; MPE) and supported by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR).

Current development models explain that when gas-rich galaxies merge and interact, star formation rates are increased, and a black hole can form at the centre. But at some point, this activity stops; in just a few million years, the rate of star formation rapidly declines and the black hole stops growing. In this short period of time – in cosmic terms – the galaxies have shed extremely large quantities of material, around a billion solar masses. What physical processes are behind this?

Herschel may now have found the answer to this mystery; the images captured by PACS suggest that the fastest winds are found in the galaxies with the brightest 'active galactic nuclei', where a giant black hole is drawing material in from its surroundings. When small galaxies merge, more material is supplied to the central black hole, increasing its size and activity. The result of this would be a wind strong enough to remove a galaxy's supply of molecular gas, which would prevent any further star formation. This confirms contemporary theories on galactic development and demonstrates the importance of galactic winds in the development of elliptical galaxies.

The images show the intermediate step in the evolution of spiral galaxies, with many young stars and a high gas content, into elliptical galaxies, that have old star populations and low gas content. They also reveal another finding; there seems to be a correlation between the mass of the black hole in the centre of a galaxy and the mass of the stars within the galaxy. Such a correlation would be a natural consequence of the galactic winds that have now been discovered, as they remove the common gas reservoir and suppress both star formation and growth of the black hole.

### **Storms in AGN and starburst galaxies**

The observations are not sufficient to definitively determine the driving force behind these winds; there seem to be two possible scenarios. Every year, 'starburst galaxies', those with a high rate of star formation, lose up to a few hundred solar masses of gas, which almost matches their rate of star formation. With speeds of a few hundred kilometres per second, these winds could be generated by the radiation pressure from the stars and starbursts.

Galaxies that are dominated by the black hole at their centre lose much more material – a thousand solar masses or more per year. Their winds, with speeds of around 1000 kilometres per second, could be caused by the radiation pressure from the active galactic nuclei. To confirm these initial results and determine other properties of the winds, Herschel-PACS will continue to perform observations in a larger number of galaxies.

## Herschel – a space observatory for infrared radiation

ESA's Herschel infrared observatory was launched on 14 May 2009 on board an Ariane 5 ECA from Europe's Spaceport in French Guiana. Since then, it has been exploring space at wavelengths between 55 and 670 microns, delivering new knowledge on the formation and evolution of galaxies. Herschel carries three instruments: the Heterodyne Instrument for the Far-Infrared (HIFI), which is a high-resolution spectrometer operating at 157–212 microns and 240–625 microns; the Spectral and Photometric Imaging Receiver (SPIRE), an imaging photometer and imaging Fourier transform spectrometer for wavelengths ranging from 194 to 672 microns; and the Photodetector Array Camera and Spectrometer (PACS), a photometer and medium-resolution imaging spectrometer operating between 55 and 210 microns.

PACS was developed under the leadership of MPE and supported by DLR with funds from the German Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie; BMWi). Germany also contributes the largest share to the Instrument Control Centre, which is responsible for operating the scientific instruments, and was significantly involved in the development of HIFI.

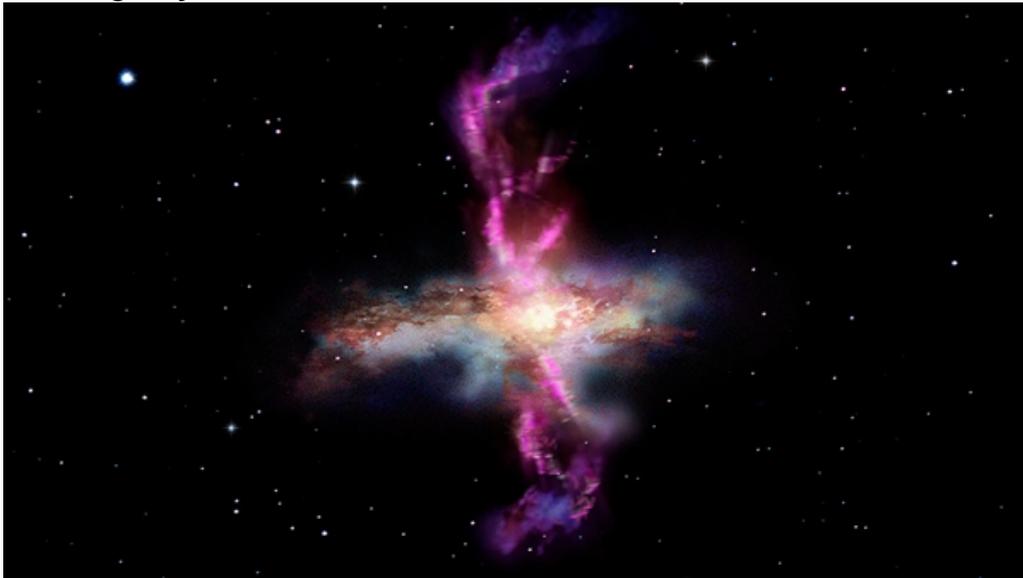
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### Infrared galaxy with massive winds



This illustration, created using Herschel data, shows massive molecular gas winds in a very luminous infrared galaxy.

Credit: ESA/AOES Medialab.

## The Herschel space telescope



With a mirror diameter of 3.5 metres, Herschel is the largest space telescope in operation. Its three instruments allow it to explore space at wavelengths between 55 and 670 microns, delivering new knowledge about the formation and evolution of galaxies.

Credit: ESA.

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