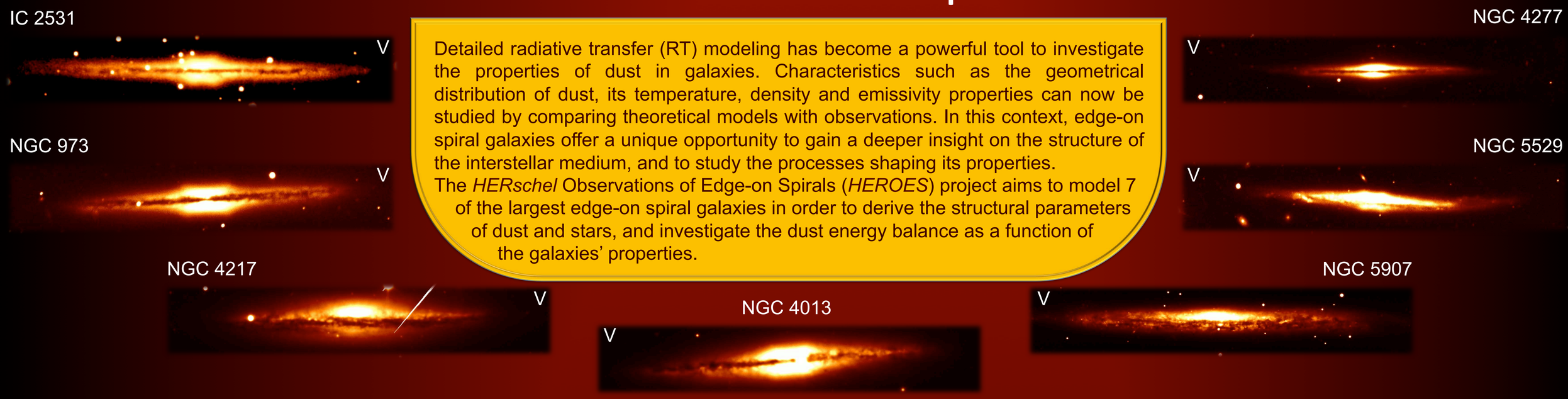
The Challenge of Radiative Transfer in Edge-on Spirals

S. Viaene[1], M. Baes, F. Allaert, S. Bianchi, J. A. D. L. Blommaert, G. De Geyter, I. De Looze, J. Fritz, G. Gentile, K. D. Gordon, B. W. Holwerda, T. M. Hughes, M. W. L. Smith, J. Verstappen and E. M. Xilouris

The *HEROES* sample



Detailed radiative transfer (RT) modeling has become a powerful tool to investigate the properties of dust in galaxies. Characteristics such as the geometrical distribution of dust, its temperature, density and emissivity properties can now be studied by comparing theoretical models with observations. In this context, edge-on spiral galaxies offer a unique opportunity to gain a deeper insight on the structure of the interstellar medium, and to study the processes shaping its properties.

The *HERschel* Observations of Edge-on Spirals (*HEROES*) project aims to model 7 of the largest edge-on spiral galaxies in order to derive the structural parameters of dust and stars, and investigate the dust energy balance as a function of the galaxies' properties.

Modeling the Optical/NIR

We use FitSKIRT, an optimization code coupled to the state-of-the-art RT code SKIRT. FitSKIRT is able to automatically fit RT models to observed images in an unbiased way. To each of the HEROES galaxies, we perform an oligochromatic (i.e. multiple wavelengths at the same time) fit to optical/NIR data. This provides an independent measure of the dust properties in the galaxies.

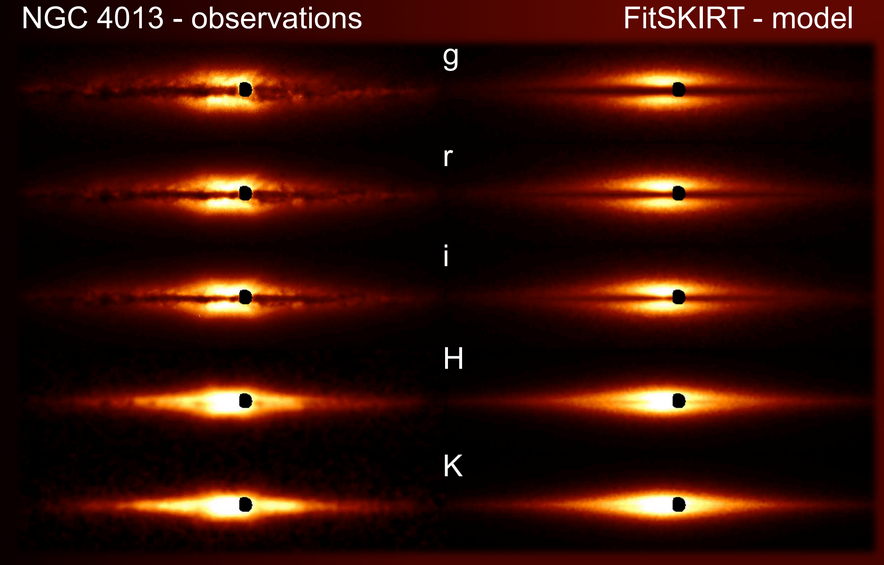


Fig. 1: Observations of NGC 4013 versus the flux from the FitSKIRT model. The model uses a flattened Sérsic bulge and double-exponential disks for the dust and stellar disk.

Observing the FIR

All seven HEROES galaxies were mapped by both PACS and SPIRE. Modified black body functions were fit to the global fluxes to estimate the basic dust properties. Due to the resolving power of Herschel, we were able to investigate the morphology of the dust disk using horizontal profiles (see figure 2). We find that an exponential disk is a good first approximation of the observed dust disk. Hence, this geometry will be used in the detailed RT models.

Furthermore, we find indications of a correlation between the vertical scale height of the dust disk and the ratio of dust masses derived from optical (FitSKIRT) and FIR (modified black body) modeling.

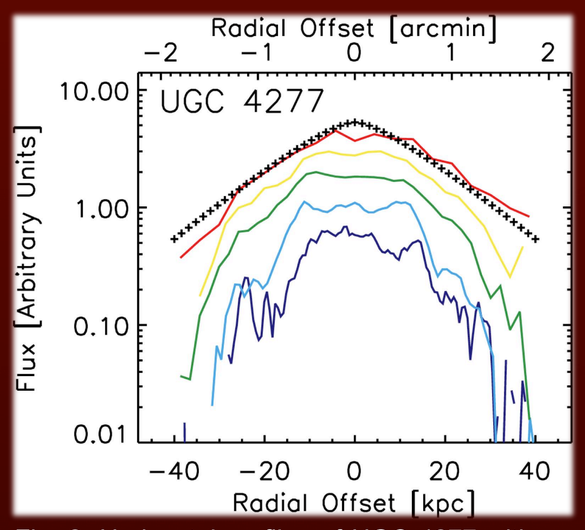


Fig. 2: Horizontal profiles of UGC 4277 with an arbitrary offset between SPIRE 500 (red) up to PACS 100 (dark blue). The black dotted line represents an exponential disk profile.

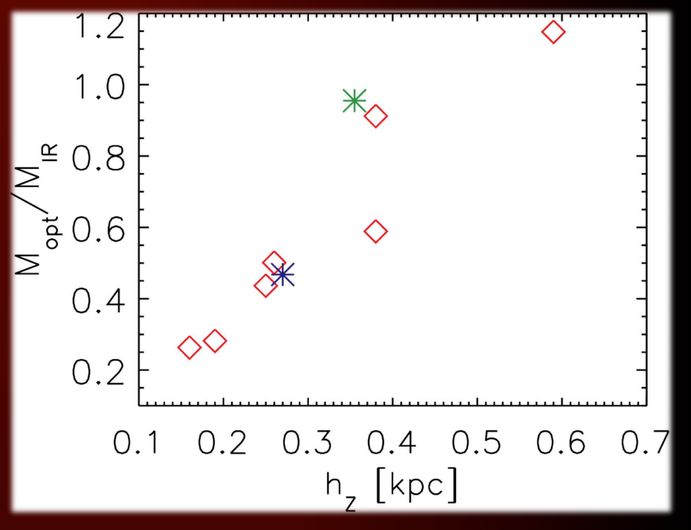


Fig. 3: Comparison of the difference in the values of the dust mass as computed from RT modeling of optical data and as computed from black-body fitting of *Herschel* data points against the dust scale height h_z.

Panchromatic RT models

Edge-on spirals are ideal objects to perform dust energy balance studies as the dust properties can be constrained from both optical an FIR observations. Starting from the FitSKIRT models, we will perform panchromatic RT simulations on the HEROES galaxies. SKIRT is able to predict the FIR/Sub-mm emission of dust grains based on realistic heating mechanisms. Comparing the numerical predictions from SKIRT with the observational data will shed light on the dust energy balance in these objects.

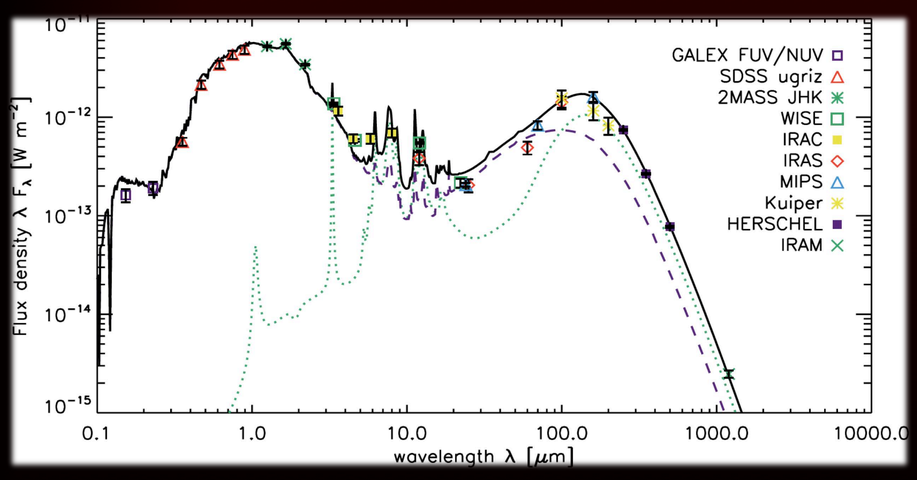


Fig. 4: SKIRT predicted SED compared to observational data of NGC 4565 (De Looze et al. 2012). Similar dust energy balance studies will be carried out for the HEROES galaxies.

Pixel-by-pixel SED fits

Simultaneously, we will perform a pixel-by-pixel SED fitting to the FIR/sub-mm data to create spatially resolved maps of the dust properties. We combine these with radio observations tracing atomic and molecular gas to resolve the gas-to-dust ratio in edge-on galaxies.

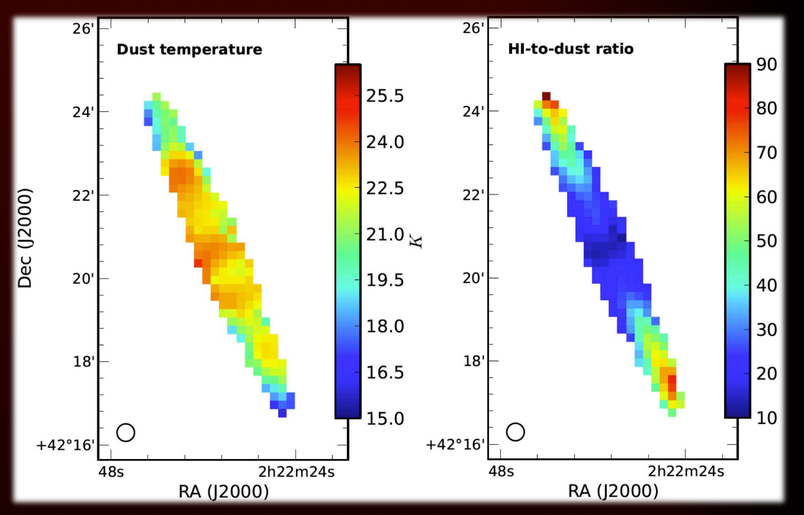


Fig. 5: Dust temperature and HI-to-dust ratio in NGC 891 as derived from pixel-by-pixel SED fitting to FIR and sub-mm observations. See also the poster P16 by T. Hughes et al.

HEROES

FitSKIRT

Panchromatic RT

SKIRT

[1]Sebastien.Viaene@Ugent.Be