

Past and current research activities¹

Development of new cooling methods for hydrocodes (MSc thesis, 1996-1997)

Cooling by molecular emission lines plays an important role in the evolution of molecular clouds after they encountered a shock passage. Hydrocodes, however, may have difficulties with correctly handling the cooling, since the cooling timescales are significantly shorter than the timescale of shock crossing, which actually determines the timestep used in these hydrocodes. We developed and tested numerical methods that can handle the issue of different cooling and hydrodynamical timescales, and performed a detailed comparison to find the most suitable ones. The results have been later implemented in a hydrocode to study interstellar shock-cloud collisions.

Related publication:

- *Horváth, A Jr, Kiss, Cs, Interstellar shock-cloud collision: new methods for cooling, Communication of the Konkoly Observatory 100: 271 (1997)*

Study of molecular clouds in the Cepheus-Cassiopeia Void (1996-2001)

We studied two separate regions in the Cep-Cas Void to determine the main physical properties of molecular clouds and infrared point sources inside, and also the connection to the neighbouring structures. The two main regions were the area around Khavtassi-15 (Kiss et al., 2000) and the environment of LDN 1274 (Nikolic et al., 2001). The study included millimetre line observation (CO, CS, HCN, etc. and their isotopic lines) and the analysis of the available infrared data. A special emphasis was given on the determination of a proper distance, with a detailed analysis of Wolf-diagrams based on objective prism spectra.

Related publications:

- *Kiss Cs, Tóth L V, Moór A, Sato F, Nikolić S, Wouterloot J G A, Low mass clouds in the Cepheus-Cassiopeia void. I. Khavtassi 15, ASTRON ASTROPHYS 363: 755-766 (2000)*
- *Nikolić S, Kiss Cs, Johansson L E B, Wouterloot J G A, Tóth L V, LDN 1274: A multiwavelength study of a dark cloud in the Cep - Cas void, ASTRON ASTROPHYS 367: 694-704 (2001)*

The large-scale structure of the interstellar medium in the neighbourhood of the Solar System (2000-2007)

The large scale spiral structure of the Galaxy is affected by the complex distribution of cavities, filaments, arcs, loops and shells, often referred to as the "Cosmic Bubble Bath". First examples of such features were found in radio continuum measurements, extended to high galactic latitudes (Loop I, II and III). Later anomalous HI features like worms, chimneys and supershells were identified and catalogued. Similar morphology has been recognized in some nearby spiral and irregular galaxies (M31, M33, LMC, SMC). The most studied Galactic shells are formed by supernova explosions and winds of massive stars. High velocity clouds infalling from the Halo and gamma ray bursts may also be responsible for the formation of the largest supershells. Nonlinear development of instabilities in the interstellar medium may form large cavities without stellar energy injection, which can be very similar to those created by SN explosions or stellar winds. These shells/loops may also provide a nest for the next generation of stars via the process of propagating star formation.

In our study we searched the far-infrared sky for these loop or arc-like features (IRAS Sky Survey Atlas at 60 and 100 μ m, and reprocessed plates). We altogether identified and catalogued 462 loops, catalogued their basic properties and provided a list of associated objects. We were able to derive distances for 73 loops. Apart from the catalogue, the loops gave an excellent statistical basis to obtain information on the large-scale structure of the local interstellar medium, e.g. to estimate the hot gas filling factor or the mechanical luminosity distribution of supernova and stellar wind bubbles in the Milky Way, which were hardly constrained observationally before. Analysis of the size distributions have shown a difference in spatial structure at low and high Galactic

latitudes and provided evidence for the first time that the structure of the interstellar medium is governed by supersonic turbulence further out from the Galactic midplane.

Related publications:

- Kiss Cs, Moór A, Tóth L V, *Far-infrared loops in the 2nd Galactic Quadrant*, *ASTRON ASTROPHYS* 418: 131-141 (2004)
- Könyves V, Kiss Cs, Moór A, Kiss Z T, Tóth L V, *Catalogue of far-infrared loops in the Galaxy*, *ASTRON ASTROPHYS* 463: 1227-1234 (2007)

Changes of far-infrared dust emissivity properties in dark clouds (2003-2006)

The far-infrared (FIR) emissivity of dust is an important parameter characterizing the physical properties of the grains. With the availability of stellar data bases and FIR data from *Infrared Space Observatory (ISO)*, it was possible to compare the optical and infrared properties of dust, and derive the FIR emissivity with respect to the optical extinction. The results show an emissivity enhancement in the low temperature regime ($12\text{K} \leq T_d \leq 14\text{K}$), suggesting grain growth in those regions. However, the amount of emissivity increase restricts the possible grain growth processes to ice mantle formation and coagulation of silicate grains, and excludes the coagulation of carbonaceous particles on the scales of the regions we investigated. The observed systematic decrease of emissivities in the $14\text{K} \leq T_d \leq 16\text{K}$ temperature range are likely explained by the common effect of constant emissivity and multiple dust temperatures along the line of sight. This work is going to be extended to a comparison of deep extinction data (obtained by INT observation in 2006) and infrared emission maps of dark clouds. The main aim of this study is to find the relationship between the changes of optical extinction and far-infrared emission properties, which holds valuable information on the evolution and state of dust grains in the dense core of the molecular clouds.

Related publications:

- del Burgo C, Laureijs RJ, Abraham P, Kiss Cs, *The far-infrared signature of dust in high-latitude regions*, *MON NOT R ASTRON SOC* 346: 403-414 (2003)
- Kiss, Cs.; Abraham, P.; Laureijs, R. J.; Moór, A.; Birkmann, S. M., *Constraints on the nature of dust particles by infrared observations*, *MON NOT R ASTRON SOC* 373: 1213-1226 (2006a)

The components and structure of the infrared sky background (from 2000 onwards)

The sky background is an important limitation for infrared observations, especially due to the small-scale brightness fluctuations that limits the accuracy of compact source photometry (the so-called confusion noise). The most important components of the infrared sky background are the cosmic infrared background, the Galactic cirrus emission and the thermal emission of small and microscopic bodies in the Solar System (thermal emission of zodiacal dust particles and asteroids). In our studies we analysed the sky structure and developed methods to separate the different components (Kiss et al., 2001, 2003). An independent determination of the absolute level of the cosmic infrared background was also given at 90 and 170 μm (Kiss et al., 2001). We also gave confusion noise estimates for current and future infrared space instruments (Kiss et al., 2005), and studied the contribution of asteroids to the infrared confusion noise (Kiss et al., 2006b). These studies served as a basis for the development of the Herschel Confusion Noise Estimator (see the relevant section below).

Related publications:

- Kiss C, Abraham P, Klaas U, Juvela M, Lemke D, *Sky confusion noise in the far-infrared: Cirrus, galaxies and the cosmic far-infrared background*, *ASTRON ASTROPHYS* 379: 1161-1169 (2001)
- Kiss Cs, Abraham P, Klaas U, Lemke D, Héraudeau P, Del Burgo C, Herbstmeier U, *Small-scale structure of the galactic cirrus emission*, *ASTRON ASTROPHYS* 399: 177-185 (2003)
- Héraudeau Ph, Oliver S, del Burgo C, Kiss C, Stickel M, Mueller T, Rowan-Robinson M, Efstathiou A, Surace C, Tóth L V,

The European Large Area ISO Survey - VIII. 90- μ m final analysis and source counts, MON NOT R ASTRON SOC 354: 924-934 (2004)

- *Kiss Cs, Klaas U, Lemke D, Determination of confusion noise for far-infrared measurements, ASTRON ASTROPHYS 430: 343-353 (2005)*
- *Kiss Cs, Pál A, Müller Th, Ábrahám P, An asteroid model of the mid- and far-infrared sky, PUBL ASTRON DEP EÖTVÖS UNIV - PADEU 17: 135- (2006b)*

Dense cores and star formation in the dark cloud complex LDN1188

Introduction: LDN 1188 is a star-forming dark cloud complex located at the edge of the Cepheus-bubble and is an ideal target to study the propagating star formation. We analysed the spectral energy distribution of several infrared sources and identified one Class-0 candidate (IRS-5) and two Class-I candidates (IRS 4 and 6). In a further investigation of the infrared sources, the environment of IRS 4, 5 and 6 were mapped with the IRAM/MAMBO-II bolometer at 1.2mm. These measurements resolved IRS 4 and 6 into several sub-sources. The state of the molecular gas around the dense condensations in the complex was studied by CS and HCO⁺ molecular line observations with the Onsala-20m radio telescope, and three NH₃ cores were identified using Effelsberg-100m NH₃ (1,1) and (2,2) cm-line measurements. The environment of IRS 4 was observed by the Spitzer Space Telescope in the First Look Survey Galactic Plane Component in IRAC and MIPS photometric bands. The IRAM and Spitzer measurements confirmed the Class-I nature of the main sources in IRS-4 and IRS-6. We started an extensive monitoring of the target both in optical and in near-infrared wavelengths (the work is still in progress).

References:

- Könyves, V, Moór, A, Kiss, Cs, Ábrahám, P, BALTIC ASTRONOMY 13: 470 (2004)
- Kiss et al., 2007, in prep.

Calibration of ISO/ISOPHOT (2000-2004)

I started to work on the calibration of the ISOPHOT (the photopolarimeter on-board the Infrared Space Observatory) in 2000, during my stay at the ISOPHOT Data Centre (MPIA, Heidelberg), and I was working on ISOPHOT data and calibration until September 2004, partly in MIPA, Heidelberg and partly in Konkoly Observatory, Hungary (the two institutions had coordinated effort in the ISOPHOT calibration). My main calibration topics were the following:

- refinement of point source photometry
- scientific validation of the mini-map observing mode
- evaluation of compact source photometry of various object types and observing modes with ISOPHOT ingestion of catalogues to the ISO Archive
- re-calibration of the internal Fine Calibration Sources
- various aspects of the absolute surface brightness photometry of ISOPHOT

Calibration of Herschel/PACS (from 2004 onwards)

I have been coordinating the calibration activities of the Photometer Array Camera and Spectrometer (PACS) of the Herschel Space Observatory in the Infrared and Space Astronomy Group at Konkoly Observatory. Our calibration activities included instrument level tests at different stages of detector development (e.g. various spectrometer tests, photometer cooler recycling, calibration source emissivities, etc., at CQM, EQM and FM levels), and the calibration and validation of the frequency switching astronomical observing template of the PACS spectrometer.

Development and scientific coordination of the Herschel Confusion Noise Estimator (from 2004 onwards)

The Herschel Confusion Noise Estimator (HCNE) is a core application in HSpot, the observation planning tool of the Herschel Space

Observatory. HCNE gives confusion noise estimates for the observation conditions (observing mode, sky position, photometric band, etc.) specified by the observer, considering the main contributors to the FIR and submm sky background, the extragalactic background and the Galactic cirrus emission. The development of the core of HCNE was done by me, and was implemented in the HSpot environment by the NASA Herschel Science Center (CIT/IPAC) and is active in HSpot since the Guaranteed Time Key Programme Announcement of Opportunity (V2.0, see the Guaranteed Time Key Program AO webpage: "http://herschel.esac.esa.int/ao_kp_documentation.shtml" for details). Future updates of HCNE will be focused on the instrumental aspects. HCNE is a coordinated effort of the Herschel Science Centre (ESA), the NASA Herschel Science Center and Konkoly Observatory, under my scientific coordination.