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Review of the doctoral dissertation by Emily Lynette Kosmaczewski, entitled „Multi-Wavelength Diagnostic of Cosmic Dust: From Galactic Dust Clouds to Young Active Galaxies"

Ms Emily Lynette Kosmaczewski's doctoral thesis concerns problems related to the study of dust in the interstellar medium in our and other galaxies. Despite the fact that dust accounts for only about 1% of baryon matter, it is important in areas where a sufficiently low temperature allows it to form and/or survive, i.e. in: envelopes formed during late stages of stellar evolution; the interstellar medium (ISM); and especially star forming regions; or gas-and-dust tori around central black holes in galaxies. Dust absorbing short-wave radiation heats up and emits in infrared, allowing, mainly due to satellite observations, to study the physical processes that are not accessible for observation in other wavelength ranges.

In her doctoral dissertation, MSc Kosmaczewski shows how dust can be used for research on various astronomical scales, using observations in the entire range of the electromagnetic spectrum. She convincingly demonstrates that important results can be achieved by using this modern astrophysical approach. The PhD thesis is a compilation of three multi-author research papers, two of which are published and one is under review but is available on astro-ph. However, this is not a simple "staple" of three re-/pre-prints (as is a rule in my home Institute) but the edited book. Such approach is used in different countries, in particular in the Netherlands, and requires from the candidate additional careful work.
The first paper (Chapter 2) shows the application of dust and observations across the electromagnetic spectrum to the youngest galaxies that are radio-active, while the other two concern the dark globule DC 314.8-5.1 and show how the approach of the candidate allows the search for "seeds" of stars in this molecular cloud and estimation of its physical properties. I will now evaluate the dissertation chapter by chapter.

Abstract and Introduction

The main dissertation (Chapter 2-4) is preceded by an abstract and an introduction. The several-page Introduction to the dissertation is presented briefly and interestingly, but it was impossible for the author to avoid minor mistakes or a few typos, which, however, do not discredit the text in any way (the noticed list of mistakes is given below). In the Introduction, MSc Kosaczewski describes clearly the current knowledge about dust together with the ubiquity of aromatic bands, commonly attributed to aromatic hydrocarbons, and the importance of dust for star-forming processes, including effects of interaction with cosmic rays. Then she describes the knowledge about molecular clouds and star-forming processes along with showing the diversity of processes that can be inferred from observations in different wavelength ranges. The end of the Introduction describes in an accessible way the present knowledge about dust in the central regions of galaxies with active nuclei. I consider this part of the dissertation to be a well-written introduction to the dissertation, which is very useful for a reader less familiar with the subject of her research. Summing up, a comprehensive but still informative and useful Introduction.

Minor comments/questions:
Abstract

In the 1st sentence: what does "carbon emissions on earth" mean when it comes to the role of dust in the universe?

In the 2nd para: taurus -> torus

Introduction:

At the end of Sect. 1.1.1: reside -> is typed twice.

Sect. 1.1.2:
I agree that the isolated PAHs emit/absorb lines (like any form of gas: molecular or atomic). However, in the universe PAH features are observed, which are much wider than the molecular or atomic lines, and they are better called a “band”.

hte vibrational modes -> the ….

Sect. 1.2: where as -> whereas (I supouse)

Sect. 1.2.1, p.12: temperature (~ 10keV)….. [K]?

Sect. 1.2.2., bottom of p.14 and top of p.15: where as -> whereas

Sect. 1.2.2., top of p. 15. The physical explanation for the absence (extreme weakness) of H_2 rotational transitions is that H_2 is a symmetric molecule and its dipole moment is zero. High temperature or shocks are needed to excite vibrational transitions.

Chapter 2

This paper published in ApJ, deals with analysis of the most compact radio galaxies, so called GHz-peaked spectrum (GPS), and compact symmetric objects (CSO). The general idea behind such investigations is to discover mechanism responsible for the triggering relativistic jets, as well as feedback between central massive black hole (BH) and the interstellar medium. The author investigate the mid-infrared (MIR) properties of 29 compact radio galaxies with X-ray detections, using data from WISE, IRAS and Spitzer Space Telescope (SST). Diversity of mid-IR colors in the analyzed sample is caused by the different dominant contributors to the MIR emission: circumnuclear dust, or ISM of host galaxy, or even the non-thermal emission from jets and lobes. Quite unexpected result is obtained in the case of CSO sources with MIR dominated by the ISM, since they are distributed almost uniformly in the whole region populated by galaxies with significant star formation activity, while their likely successors, Fanaroff-Riley type II radio sources are rather confined to the region occupied by ellipticals with small star formation on the MIR color-color diagram. In addition, as noted in the paper the ongoing star formation activity seems to have no much effect on triggering radio jets.

Minor comments:
On p. 36 “top right panel” should be replaced by “bottom left panel” while comparing the authors’ sample with the Kozieł-Wierzbowska & Stasińska sample. And opposite should be done for comparison with the Kuźmicz sample.
In the caption of Figure 2.6: Bottom panel -> Bottom right panel

Chapter 3

This article was also published in ApJ and is devoted to the study of dark globule DC 314.8-5.1 based on infrared spectra ranging from 5 to 35 micrometers from the IRS instrument aboard the SST satellite. In this spectral range, the dominant dust structures are the bands of policyclic aromatic hydrocarbons (PAH). This globule is illuminated on the one side by a hot type B star, exciting PAH and inducing their emissions. The author skillfully used the publicly available PAHFIT and pypahdb numerical tools for the analysis, drawing some interesting conclusions about the state of PAH (degree of ionization, size and state of reprocessing under the influence of UV radiation) in this dark nebula and the influence of cosmic rays on the regions of the nebula inaccessible to the ionizing radiation of this B star. The author's conclusion is that the physical conditions in this dark globule are more diverse than in molecular clouds with the ongoing star formation. In my opinion, the author has demonstrated great interpretative skills by showing how the dust emission from different regions of the nebula can be used to investigate indirectly its physical and chemical conditions.

Minor comment:
The caption to Figure 3.10 mentions the temperature of 40K, while the inset in this figure does not contain this temperature value. This is strange as the text states that “… the most prominent dust continuum component corresponds to the temperature of 40 and 35 K.” The same is true for the original article.

Chapter 4

This is the second dark globule DC 314.8-5.1 article that was sent for review to ApJ. This time, the candidate uses data from a wide range of the electromagnetic spectrum, from X and UV to the sub-millimeter range, to search for newly forming stars in this cloud. A very sophisticated and interesting analysis which shows finally that there are no proto-stellar objects in it yet and thus DC 314.8-5.1 is in the pre-star forming state. The author, after finding candidates, uses data from Gaia's projects to check whether the selected objects are physically related to this cloud. It is worth emphasizing that the author skillfully analyzes and interprets her own observations in the X and UV range. While searching for young stellar object (YSO) candidates among the objects observed by SST, the candidate indicates that she uses the "method" described in the work of Karska et al. (2022), which is a modification of the Gutermuth et al. (2009) method for objects with any but known distance. However, this method is not used in the candidate work. In principle, it was possible to check with Gaia data whether among all the sources observed by SST (1319 + 164) there are objects located close to DC 314.8-5.1 and only among these objects to look for YSOs. Otherwise, the reference to Karska et al (2022) should be deleted. It is worth emphasizing that the discussion at the end of the article is very interesting and shows the candidate's versatility in interpreting data in the entire spectral range.

Minor comments/questions:
It would be useful to explain the all acronyms used in the text (e.g. UVOT, ToO, SEIP, …)

Sect. 4.2.1, second para in the Planck section: The upper panel of Figure 4.1 -> The left panel of Figure 4.1
second para in the IRAS section: The lower panel of Figure 4.1 -> The right panel of Figure 4.1

Discussion
p.91, first line: “One is the thermal emission of the dominant cold gas and dust…” How “thermal emission of cold gas” has been modelled in Fig.4.8?

p.92. It would be very instructive and useful to add wavelengths in micrometers to the upper axis.

Conclusions
p.94. 2. This conclusion is written in a confusing way. “<” suggests that weaker objects can be observed, while the second sentence says that the brightest PMSs need deeper observations.

Summing up, I think that Ms Emily Lynette Kosmaczewski's doctoral dissertation is valuable and meets the formal requirements for doctoral dissertations. It allows me to inference for admitting Emily Lynette Kosmaczewski to further stages of the process, including the public defense of her doctoral dissertation.

Ryszard Szczerba