Astronomy Science Papers

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Outline

• Types of Science Articles
• Professional Astronomy Journals
• Finding Publications
• Paper Organization
• LaTeX
• Practical Process for Paper Writing
• Publication Statistics
Types of Science Articles
Journal articles

- Peer-reviewed
- Contain validated science results
- Used as primary reference material for other science results
- May only be fully accessible with a subscription (through a university, for example)
Conference proceedings

- Summaries of results presented at a conference
- Not always reviewed before publication
- Usually include results that later appear in a journal

Investigations of dust heating in M81, M83 and NGC 2403 with Herschel and Spitzer

George J. Bendo and the Herschel-SPIRE Local Galaxies

Guaranteed Time Programs

Abstract. We use Herschel Space Observatory and Spitzer Space Telescope 70-500 μm data along with ground-based optical and near-infrared data to understand how dust heating in the nearby face-on spiral galaxies M81, M83, and NGC 2403 is affected by the starlight from all stars and by the radiation from star-forming regions. We find that the 70/160 μm flux density ratios tend to be more strongly influenced by star-forming regions. However, the 250/350 and 350/500 μm micron flux density ratios are more strongly affected by the light from the total stellar populations, suggesting that the dust emission at >250 μm originates predominantly from a component that is colder than the dust seen at <160 μm and that is relatively unaffected by star formation activity. We conclude by discussing the implications of this for modelling the spectral energy distributions of both nearby and more distant galaxies and for using far-infrared dust emission to trace star formation.

Keywords. galaxies; ISM; infrared; general

1. Introduction

After the completion of the all-sky surveys by the Infrared Astronomical Satellite, astronomers have found conflicting evidence for the heating sources of the dust producing far-infrared emission in nearby galaxies. Some authors claimed that the dust was heated primarily by star formation (e.g. Dwek & Young 1990; Hunt & Xu 1996) while others indicated that evolved stellar populations could heat the dust (e.g. Surace & Thron 1992; Walterbos & Greenewalt 1996). This issue has become more important since the launch of the Herschel Space Observatory (Pillai et al. 2010). Herschel has been able to produce high signal-to-noise >250 μm images of both nearby and more distant galaxies, so it will be highly sensitive to colder dust that may have been missed by telescopes primarily observing at shorter wavelengths.

Several papers have been published on the sources of the heating for the dust emitting at Herschel wavelengths (e.g. Bendo et al. 2010, Rowan-Robinson et al. 2010, Boquien et al. 2011). We will focus on the results from Bendo et al. (2011) on the spiral galaxies M81, M83, and NGC 2403. Their analysis was based on comparing the infrared surface brightness ratios to Hα emission (used as a tracer of star formation) and 1.6 μm emission (used as a tracer of the emission from the total stellar population). The infrared surface brightness ratios depend on dust heating, so they will appear correlated with the emission tracing the dust heating sources.
Preprints

- Pre-published versions of papers
- Usually fall into one of three categories:
  - Papers that have been accepted for publication but not yet published
  - Papers that have been submitted for publication but not yet reviewed
  - Papers that people are not going to try to submit
- Freely accessible

Tests of star formation metrics in the low metallicity galaxy NGC 5253 using ALMA observations of H30α line emission

G. J. Bendo, R. E. Miura, D. Espada, K. Nakajima, R. J. Beswick, M. J. D’Cruz, C. Dickinson, G. A. Fuller

ABSTRACT

We use Atacama Large Millimeter/submillimeter Array (ALMA) observations of H30α (231.90 GHz) emission from the low metallicity dwarf galaxy NGC 5253 to measure the star formation rate (SFR) within the galaxy and to test the reliability of SFRs derived from other commonly-used metrics. The H30α emission, which originates mainly from the central starburst, yields a photometrically-based photometric production rate of (1.9 ± 0.3) × 10^{-25} erg s^{-1} and an SFR of (0.087 ± 0.013) M_☉ yr^{-1} based on conversions that account for the low metallicity of the galaxy and stellar rotation. Among the other star formation metrics we examined, the SFR calculated from the total infrared flux was statistically equivalent to the values from the H30α data. The SFR based on previously-published versions of the H0 flux that were extinction corrected using Pas and Pci lines were lower than but also statistically similar to the H30α value. The mid-infrared (22 μm) flux density and the composite star formation tracer based on H0 and mid-infrared emission give SFRs that were significantly higher because the dust emission appears unusually hot compared to typical spiral galaxies. Conversely, the 70 and 160 μm flux densities yield SFR lower than the H30α value, although the SFRs from the 70 μm and H30α data were within 1-2σ of each other. While further analysis on a broader range of galaxies is needed, these results are instructive of the best and worst methods to use when measuring SFR in low metallicity dwarf galaxies like NGC 5253.

Key words: galaxies: dwarf - galaxies: individual: NGC 5253 - galaxies: starburst - galaxies: star formation - radio lines: galaxies

1 INTRODUCTION

Star formation in other galaxies is typically identified by looking at tracers of young stellar populations, including either photometrically-luminous stars, ultraviolet-luminous stars, and supermassive. The most commonly-used star formation tracers are ultraviolet continuum emission, Hα (6563 Å) and other optical and near-infrared recombination lines; mid- and far-infrared continuum emission; and radio continuum emission. However, each of these tracers has disadvantages when used to measure star formation rates (SFRs). Ultraviolet continuum and optical recombination line emission directly trace the young stellar populations, but dust obscuration typically affects the SFRs from these tracers. Near-infrared recombination line emission is less affected by dust obscuration, but it is still a concern in very dusty starburst galaxies. Dust continuum emission in the infrared is unaffected by dust obscuration except in extreme cases, but since this emission is actually a tracer of bolometric stellar luminosity and not just the younger stellar population, it may yield an overestimate of the SFR if many evolved stars are present. Radio continuum emission traces a combination of free-free emission from photionized gas and synchrotron emission from supernova remnants, so proper spectral decomposition is needed to accurately correct radio emission to SFR. Additionally, the cosmic rays that produce synchrotron emission will travel significant distances through the ISM, making radio emission appear diffuse relative to star formation on scales of ~100 pc (Murphy et al. 2006a,b).

Higher-order recombination line emission at millimetre and submillimetre wavelengths, which is produced by the same photionized gas that produce H0 and other optical and near-infrared recombination lines, can also be used to measure SFR. Unlike ultraviolet, optical, and near-infrared star formation tracers, these millimetre and submillimetre recombination lines are not affected by dust extinction and radio synchrotron emission, the recombination lines directly trace the star-forming regions. Recombination line emission can also be observed at centimetre and longer wavelengths, but the line emission at these longer wavelengths is generally affected by a combination of dust effects and opacity issues in the photionized gas, while the millimetre and submillimetre lines are not (Greisen & Wardle 1990).
Press releases

- Articles written for distribution to newspapers
- Not necessarily based on published science
- Usually not peer-reviewed
Popular science articles

- Articles written for magazines for the general public (e.g. Astronomy, Sky & Telescope)
- Not necessarily peer-reviewed
- Usually uncontroversial science
Technical papers

- Usually include support information for observatories or software
- Usually reviewed by other people in the project but not peer-reviewed
- Freely accessible
Professional Astronomy Journals
Primary astronomy journals

- Astronomical Journal
- Astronomy & Astrophysics
- Astrophysical Journal
- Monthly Notices of the Royal Astronomical Society
Astronomical Journal

AJ
iopscience.iop.org/journal/1538-3881

- The oldest American astronomy journal
- Associated with the American Astronomical Society (AAS)
- Charges for publishing
- Articles can be made open access for an additional charge
Astronomy & Astrophysics

A&A
www.aanda.org

- Europe’s main astronomy journal
- Free to publish for people in the UK (except for excessively long papers)
- Articles become open access one year after publication
Astrophysical Journal

ApJ
iopscience.iop.org/journal/0004-637X

- The most highly cited main astronomy journal
- Associated with the American Astronomical Society (AAS)
- Charges for publishing
- Articles can be made open access for an additional charge
Monthly Notices of the Royal Astronomical Society

MNRAS
academic.oup.com/mnras

- The main astronomy journal for the United Kingdom
- Associated with the Royal Astronomical Society (RAS)
- Charges for publishing colour figures in the print version
- Articles can be made open access for an additional charge
Other astronomy-related journals
(not a complete list)

- **Annual Review of Astronomy & Astrophysics (ARA&A)** – A good source for overview information on research topics
- **Icarus** – A journal oriented towards planetary astronomy
- **Nature** – A journal covering a broad range of sciences that published high-profile results (including astronomy results)
- **Publications of the Astronomical Society of Japan (PASJ)** – Japan’s main astronomy journal
- **Publications of the Astronomical Society of the Pacific (PASP)** – Often used to present background information on surveys
- **Science** – Another journal covering a broad range of sciences that published high-profile results
Variants of the main journals

- **Letters** – Short articles that are published on a short timescale; used to highlight new results without providing in-depth information

- **Supplements** – Used to publish large datasets
Fake or questionable journals

Some legitimate journals not listed above deal with specialty topics or are focused on fields other than astronomy. However, beware of “[journals]” that do not appear on this list and that are unfamiliar to your supervisor.

Some other signs that an astronomy journal may either be fake or otherwise questionable:

- You receive email requests from the journal for articles.
- You receive email requests from the journal to be a guest editor.
- The journal is never cited in any scientific papers that you read.
- No one at your university has published in the journal.
- No one at your university has heard of the journal.
- The journal has not been around for more than 10 years.
- The journal is not associated with a major research organization.
- The journal’s editorial board is either not shown or consists of relatively unknown people.
Finding Publications
In the mid-1990s, astronomers set up the ADS Abstracts website to catalogue all professional astronomy publications.

The website is accessible at adswww.harvard.edu/ads_abstracts.html.

Try looking up the webpage now.
The original version of the website is at adsabs.harvard.edu/abstract_service.html.

This has fields for searching for the following:

- Author
- Object name
- Title words
- Abstract words

The form also has multiple options for narrowing down the search or sorting the results.

The results can be sorted afterwards.
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The form also has multiple options for narrowing down the search or sorting the results.

The results can be sorted afterwards.
The new version of the website is at ui.adsabs.harvard.edu.

This has one entry field, but it is possible to perform multiple types of queries.

The list of results can be filtered afterwards.
Tips on using ADS Abstracts

• To search for first-author papers, use a “^” in front of the name (for example, “^Smith”).

• To search for last-author papers, use a “$” after the name (for example, “Smith$”).

• With very common names, it may be useful to use the Boolean logic options to remove some entries with initials that do not quite match.

• In the classic form, using the “and” options will limit the total number of results.

• When filling in multiple input fields in the classic form, it is important to check the “Require for selection” boxes.

• Filtering by refereed articles is often useful for reducing the number of results.
The arXiv website at arxiv.org carries preprints of many journal articles and some conference proceedings.

Some people also use it to “publish” results when they cannot get their articles accepted by any journals.

The new submissions list is updated every weekday. Some people use this list to keep up on astronomy research.
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Paper Organization
Astronomy papers are generally organized along the following outline:

- Introduction
- Data
- Analysis
- Discussion
- Conclusions

However, many papers will frequently reorganize the material in unusual or creative ways. It is rare to actually see a paper with five sections with these labels.
Title

The paper begins with the title.

The title should communicate what the paper is about as briefly as possible.

However, you can have fun with making creative titles.
Author list

Underneath the title is the author list (as well as a list of everyone’s affiliations).

Including every possible contributor in the author list is important to ensure that everyone’s contribution is acknowledged.

However, some author lists can get inanely long.
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Abstract

The abstract provides a short summary of the paper.

This might be the only thing that people every read from your paper.

Ensure that you present all of your most important results in as few words as possible.
Keywords

The keywords are useful for indexing your paper’s results.

Otherwise, the keywords are just a small formality in writing a paper.
Introduction

The introduction serves three main purposes:

• It reviews the research material in the field.

• It explains why the research in the paper is needed.

• It explains what research is actually going to be presented in the paper.
Data

The data section describes the data used in the analysis.

Since a lot of data is made public these days, it is very important to provide details on the data processing when possible so that people can replicate your results.

When reading a paper, though, the observations and data reduction can be rather uninteresting (unless you are trying to recreate someone else’s images or spectra).
The data section could often be split into a few different sections, such as the following:

- **Sample** – People often select subsets of objects to work with and need to explain how they selected these objects.

- **Observations** – If the paper is presenting new data, it is important to describe how those observations were done.

- **Data reduction** – It is important to document how the observations were converted into actual usable images or spectra.
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Analysis

The analysis contains the science results presented by the paper.

However, the paper may examine multiple science questions, in which case the analysis may actually be divided across multiple sections.

This part of the paper also usually has the most important images.
Discussion

The discussion section usually states the implications for the analysis results. This is also a good place to discuss the analysis results from your paper in the context of results from other papers.
Conclusions

The conclusions should provide a quick summary of the important science results from the paper.

The conclusions do not need to summarize the entire paper.
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The conclusions do not need to summarize the entire paper.
Acknowledgments

The acknowledgments are usually at the end of the conclusions and usually list contributions from other people towards the paper.

People or things that could be mentioned here include:

- The referee
- Other people whom you talked to about the paper
- Observatories
- Software developers
- Websites with useful information
- Scientific grants
The references section presents a list of all the papers that are mentioned in the text. It generally makes people feel better if you reference their papers, so it is OK to have lots of references.

Also, when appropriate, try to include references to online documents (such as observational or instrument manuals) and textbooks as well as scientific articles.
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Appendices

The appendices include supplementary information.

This is often a good place to put the following:

• Extra figures or tables

• Information on deriving equations

• Additional analyses that help support the results from the main analysis section
How to read papers

• It is frequently sufficient to just read the **Abstract**, which should contain a basic summary of the paper.

• For slightly more information, look at the **Figures**, the **Conclusion**, and possibly some derived **Equations**.

• For more in-depth information, read the entire paper (but skip the **Data** section).

• For background information and references to other papers, read the **Introduction**.

• To simply get some numbers (e.g. distances to objects), look up the data in a **Table**.

• Refer to the **Data** section when trying to reproduce someone’s images, spectra, or measurements.
LaTeX
LaTeX

LaTeX is a typesetting system used for creating many professional journal articles.

The files look like text files with additional inserted comments.

Additional commands are specified in the text after backslashes (\).

Math symbols are specified within dollar signs ($$).
A LaTeX document usually includes the following lines:

- \textbf{\documentclass}

- Additional header statements, including the following:
  - \textbf{\usepackage}
  - \textbf{\title}
  - \textbf{\author}
  - \textbf{\date}

- \textbf{\begin{document}}

- \textbf{\maketitle}

- The text of the paper itself

- \textbf{\end{document}}
Templates

The major journals each have templates available at the following locations:

- **A&A**: www.aanda.org/author-information/latex-issues/latex-examples

- **AJ**: journals.aas.org/authors/aastex.html

- **ApJ**: journals.aas.org/authors/aastex.html

- **MNRAS**: ctan.org/tex-archive/macros/latex/contrib/mnras

You may need to write your PhD thesis in LaTeX as well. Other students at your home institution may have templates for this.
BibTeX

BibTeX is a useful way for storing citations material for papers.

When a BibTeX file is compiled with a LaTeX file, it will automatically generate a list of references in the needed format for the journal.

BibTeX files can include a list of citations used in multiple papers. The resulting reference list for any LaTeX paper will only include the papers cited in the LaTeX file.

ADS Abstracts has an option to generate entries in BibTeX format.
LaTeX editors

LaTeX documents can be edited using simple text editors (emacs, gedit, notepad, etc). The documents can then be compiled at the command line.

Windows and Mac have special packages for editing LaTeX documents. I use the following:

- TeXworks (Windows)
  www.tug.org/texworks/
- TeXShop (Mac)
  pages.uoregon.edu/koch/texshop/

LaTeX documents can also be created online using Overleaf (www.overleaf.com).
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Practical Process for Paper Writing
The timeline for writing a paper before submission usually proceeds as follows:

**2 months – 2 years**: The first author starts writing the paper. After some time, a complete paper is ready.

**2 weeks – 3 months**: The paper is reviewed by one or more people, who provide comments on what needs to be changed in the paper.

**1 – 3 months**: The first author makes changes to the paper.

The prior two steps repeat until everyone has read the paper and everyone stops generating comments on major changes that need to be made to the paper.
The timeline for a paper after submission is as follows:

**1 month:** The editors send the paper to a referee (also called a reviewer), who writes comments that are sent back to you.

**1 week – 6 months:** The first author makes changes to the paper.

The first two steps repeat until the reviewer is happy with the paper, at which time the paper is accepted for publication.
After the paper is accepted, the following should happen:

• A copy of the paper should be posted on arXiv.

• Any copyright forms need to be completed and returned to the journal.

• The proofs (the final form of the paper) should be reviewed and edited by the first author.

• Any page charges need to be paid.
Publication Statistics
Any researcher’s publication record can be measured through various metrics, including the following:

- Total number of refereed papers
- Total number of refereed first-author papers
- Total citations to (all or first-author) papers
- Normalized citations to papers (each paper’s citations is normalized by the number of authors)
- h-index (the number n where n papers have at least n citations)
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- h-index (the number n where n papers have at least n citations)
These metrics do not necessarily indicate that someone is a good or bad researcher.

- Some people could churn out a lot of papers that cite each other but otherwise achieve very little.

- Some senior researchers get more involved in grant writing, management, and/or teaching and do not publish many papers.

- Some researchers focus more on promoting their students’ and postdocs’ work and do not publish many first author papers.

- Some researchers work more on behind-the-scenes activities (e.g. instrument development and support) and may only be recognized when that effort becomes publicly visible.
You can drive up your publication statistics in a few ways.

- Publish lots of papers.
- Cite yourself frequently.
- Ask other people to cite you.
- Work in a large collaboration where people use your results.
- Publicly release your data.
- Present your results at conferences.
- Produce press releases based on your papers.