The handle [http://hdl.handle.net/1887/33224](http://hdl.handle.net/1887/33224) holds various files of this Leiden University dissertation

**Author:** San José García, Irene  
**Title:** Paving the path between low- and high-mass star formation: dynamics probed by *Herschel* far-infrared spectroscopy  
**Issue Date:** 2015-06-18
Publications

Refereed Publications


2. **San José-García, I.**; Mottram, J. C.; van Dishoeck, E. F.; van der Tak, F. F. S.; Kristensen, L. E.; Herpin, F.; et al., *Infall versus turbulence as the origin of sub-millimetre line broadening in protostellar envelopes: from low- to high-mass*. Submitted to A&A (chapter 3 of this thesis)

3. **San José-García, I.**; Mottram, J. C.; van Dishoeck, E. F.; Kristensen, L. E.; van der Tak, F. F. S.; Braine, J.; et al., *Linking low- to high-mass YSOs with Herschel-HIFI observations of water*. Submitted to A&A (chapter 4 of this thesis)


Papers in preparation

1. **San José-García, I.**; et al., *An unbiased view of the link between low- and high-mass star formation: Herschel-HIFI observations of H$_2$O and CO from the WILL and Cygnus samples*. To be submitted (chapter 5 of this thesis)

Conference Proceedings


Curriculum Vitae

I was born on the 4th of October 1986 in Elche de la Sierra, a small town in the south-east of Spain where I also grew up. Since I was little I was fascinated by science, especially astronomy, biology and mathematics. This interest increased during my high-school years and just before graduating I opted to study physics and astronomy. Therefore, in 2005 I moved to Valencia and started a Bachelor programme in General Physics at the Universitat de València. In order to broaden my educational path, in 2007 I studied for one year at the University of Leeds, in the UK, as part of the Erasmus programme. I mostly took astronomy courses which convinced me to keep specialising in this field. This experience not only allowed me to learn astronomy and another language, but it also showed me the value of living in another country.

In the summer of 2008 I won one of the 100 fellowships from the Consejo Superior de Investigaciones Científicas (CSIC) instituted to develop the research skills of outstanding young students in any field of science. Thanks to this fellowship, I worked on a project for two months at the Instituto de Astrofísica de Andalucía (IAA) in Granada, Spain, under the supervision of Dr. Miguel Ángel López Valverde. The research focused on analysing CO\textsubscript{2} emission from the atmosphere of Venus taken with the VIRTIS instrument on board of the Venus Express. By working on this topic I acquired skills for handling large databases. This positive experience convinced me to pursue a career in astronomy. In 2009, the year I finished my Bachelor degree, I applied for a summer fellowship at the Instituto de Astrofísica de Canarias (IAC) in La Laguna, Spain. The research was focused on detecting signs and traces of interactions between galaxies, such as tidal streams or extended emitted structures, which could explain the unusual low metallicity of certain massive galaxies. My contribution to the project was to provide a deep analysis of the astronomical images and to personally obtain the data with the IAC80 telescope in Tenerife. This project encouraged me to direct my research interests to the observational part of astronomy.

That same year I was awarded the prestigious Fundación Bancaria “la Caixa” - Obra Social grant to study a Master’s degree in Astrophysics at the Universidad de la Laguna, Spain. I started the Master’s programme in September 2009 and a few months later I applied for a Ph.D at Leiden Observatory, the Netherlands. I was offered the position under the supervision of Prof. Dr. Ewine F. van Dishoeck and the co-supervision of Dr. Joseph C. Mottram. Then, in August 2010 I moved to Leiden to finish my Master’s thesis working with Dr. Lars E. Kristensen and in January 2011 I officially started my Ph.D. The topic of the research is to study similarities and differences between low- and high-mass star formation by analysing the emission from CO and water molecules observed with the Herschel Space Observatory. This project was performed within the “Water In Star-forming regions with Herschel” (WISH) key programme, which brings together a large scientific community. During the Ph.D. I had the chance to work with state-of-the-art satellite data, to implement and interpret complex modelling tools, and to handle big volumes of data.
Acknowledgements

These more than 200 pages of work would have not been possible without the help, trust and encouragement of the great people that I met during the last five years. I feel tremendously lucky to have had the chance to work at Leiden Observatory, to live abroad, and to have met all of you. This enriching experience opened my eyes in ways I could not have expected. It is hard to put into words my gratitude towards this big community of friends and colleagues, but I will give it a try!

I would like to start thanking Joe, the person who has closely guided me through this process with patience and dedication, acting as my mentor. Without his help, support and encouraging words this thesis would have not been possible (neither the differentiation between “analogous/analogue/analogues”). From the very first years, I am specially thankful to Lars for giving me the initial boost toward the Ph.D. and for teaching me all the basic of this field with humor, and to Umut for unveiling the secrets of class and helping me to keep the momentum with chocolates, calzone and fun (I still wonder çoraplarım nerede?).

Special thanks to all my officemates in room 507 for creating such a warm atmosphere, so warm in fact, that they needed to open the window as soon as I was gone. In particular to Magnus (not only for making figures and sharing homemade food, but for all the funny and random conversations out of the blue) and to Daniel S. H. (I will try to pay you back all the chocolates, your help and your patience with Hello Kitty cards and clean keyboard covers on your birthday). To all the current and future inhabitants of this office, please keep watering the plants.

During these years I had the privilege to be part of a large group of great scientists and even better people. Alan (tan ingenioso), Agata (I loved your encouraging emails), Anna, Catherine, Christian, Davide, Greg, John, Kenji, Koju, Maria, Mihkel (“Komet” supplier), Nadia (¿cómo he podido vivir sin un calienta-manos?), Niels, Nienke, Paola (¿tienes una galleta?), Simon, Vianney and Xiaohu, thanks for the stimulating conversations about science and life in general, for the fancy beverage on Thursdays and for creating such a friendly environment. I would like to thank as well all the members of the AstroChemistry group, especially Gleb, Steven, Pamela, Markus, Luke, Mason, Tim and Remo (Hawaiian shopping supporter) for being always available to help with any lab/chemistry/modelling/observational doubt and always whiling to go to the borrel.

As a member of the WISH programme I had the chance to work in a large collaboration with many scientists from all around the world. I learned a lot during our intense meetings and I would like to thank the entire consortium for this peerless opportunity, in particular Nick, Luis, Fabrice, Russ, Ruud, Gina, Silvia and Per. Finally, my journey into laboratory astrophysics together with all my LASSIE fellows has been one of the most positive and enriching experiences during the Ph.D. Thank you all for the memorable moments and for creating the most friendly network ever!

In addition to the excitement of preparing observing runs in Hawaii, printing posters for conferences and hearing the sentence Hora est in friend’s defences, there have also been arduous and challenging periods during these years. Those were the moments in which key friends made the difference and helped me go on. Since it is impossible to list them all, I will start thanking my Strw and Leiden friends Alex, Andra, Cosma, Steven, Monica, Tiff, Ernst, Francisco (gran compañero de salsa), Remco, Julien, Marcello, Cristóbal & Daniela, Clément, Vacchel (¡bueno gente y gran actor!), Emanuele, Jayne, Wendy, El Rafa & Lara (los originales), Carina (con tu risa parece que hasta sale el sol), Carmen (la divina, ¡encontrarte en fiestas tiene efecto rejuvenecedor!), Jesse, Jeanette, Joana, Willem, Jaya, Pedro & Julia (always so refreshing to meet you), Mihaela (me has vestido, dado de comer y me has hecho reír... ¡no hay suficiente jamón para pagarte todo esto!), Daaaaaaaan (voy al supermercado) and Gabriela (tan dulce como fiestera). I will miss our daily complaints about weather and kroketten, our jokes, the discussions about our cultural differences or the uncertainty of the future, our coffee breaks, our chats while queuing for the microwaves, dinners, parties, random meetings in the market and bike rides to the tulip fields.

But this is not over, Carl, keep that great mood and powering laugh going. Mher, as I said
you many times, you have been a hilarious officemate (the very first one!). Bram and Sebastiaan, our disputes about the World Cup did not prevent us from having a good laugh or a beer. Heather, you are by far the nicest guy from Scheveningen I have ever met. Y our tai-chi movements (and our jokes) always help me in the stressful moments. Bere, a pesar de nuestras diferencias acerca de la “telenovela del espacio”, no hubiera podido caminar este valle sin tus alentadoras palabras. Jesús, ese valeroso (y golosón) guerrero que siempre perdía al Munchkin de forma suicida. ¡Qué bien has aguantado este sin dios! Nicola (Nikoala), quantissimo mi mancano i tuoi fashion advice, la tua giacca rossa, il tuo telefono dorato, i pomeriggi ascoltando folk olandese insieme, il tuo modo di essere rilassato (anche se prendiamo il bus sbagliato) e il fatto di dare sempre la priorità all’amicizia. Thaïs (chica rubia), you are such a colourful and caring person (except above 30 degrees or hungry), and you have demonstrated it by keeping an eye on all of us even when you were immersed in a thousand different tasks. I am so glad that Karoliina randomly matched us for the room in Toledo! Silvia (chica morena), meno male che eri qui per perderti con me a Heidelberg, per portarre all’undicesimo piano, per insegnarre la importanza dello spritz, per prendere una Lefce con me a ore sensate e per rallegrarre la giornata con il tuo buon umore, la tua pazzia e energia. Chissà quale sarà la prossima città dove suoneremo i campanelli di notte. To all of you, for being an important part of these years and making this period of my life unforgettable, thanks.

Y por supuesto, quiero dar las gracias a todas aquellas personas que me han acompañado en este viaje que empezó ya hace muchos años en un pueblecico de la sierra. Sin vosotros, sin vuestra amistad no hubiera podido llegar hasta aquí. A mis padres, quienes me han enseñado el valor de la independencia y del trabajo duro, porque todo lo que soy y lo que he conseguido es gracias a vosotros. No sólo me habéis dado alas, sino que continuáis ayudándome a volar. Héctor y Alejandro, gracias por habernos cuidado y soportado desde que era una mengaja, por hacerme reír hasta llorar (y viceversa), por enseñarle a luchar por mis sueños (o por un trozo de tomate) y por poder contar siempre con vosotros. A mis cuñadas, primos, sobrinos y tíos, por demostrarme cada día que una familia unida no tiene por qué estar junta, por todas las alegrías y por esos momentos de locura que tanto nos gustan. A mis amigos de toda la vida (Kaos, Vruskos, Vicio), gracias por estar siempre ahí para animarme y subirme la moral, por vuestra comprensión y por no dejar que pase el tiempo entre nosotros. Roberto, David, Yoli, Ruth, Jessi y Alberto, ¡no sé cómo hubiera sobrevivido a los años de universidad sin vosotros! Gracias por hacer ese periodo inolvidable, por enseñarme tanto y por seguir siendo un apoyo y una referencia. A Borja, por la increíble portada (eres un artista) y por todos los momentos absurdos. A mis insularas por las cartas, dulces canarios, mensajicos, partidas de parchís y por todo el cariño que me llegan desde el Atlántico. Y a mucha otra gente “culpable” de que haya escogido este camino y de que al fin llegué a su destino, como Antonio, Toño y Ale (gracias por ese inolvidable verano granadino y por esas largas noches en el Cebollas), Francesco (pulpoabrazos), Nicole (thanks for sooo many things that I cannot even list!), y mis tres guerreros Unai, Silvia y Belén (siempre disponibles para ayudarme, animarme y hacerme reír).

Por último, Matteo, grazie per tutto lo che hai fatto per me in queste anni di locura, per farmi ridere ogni giorni (come i polli) e per sopportare lo pesá che sono con pazienza e rotation di stupidaggini. Puoi andare a un altro paese, continente o planeta che mai avrà distancia fra noi (eccetto quando incontri un serpente per strada). Simplemente grazie! Non vedo l’ora di fare di nuovo terratremols nelle mattine.