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## **Paving the path between low- and high-mass star formation : dynamics probed by Herschel far-infrared spectroscopy**

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## Refereed Publications

1. **San José-García, I.**; Mottram, J. C.; Kristensen, L. E.; van Dishoeck, E. F.; Yıldız, U. A.; van der Tak, F. F. S.; et al., *Herschel-HIFI observations of high-J CO and isotopologues in star-forming regions: from low- to high-mass*. 2013, A&A, 553, A125 (chapter 2 of this thesis)
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)
4. Mottram, J. C.; Kristensen, L. E.; van Dishoeck, E. F.; Bruderer, S.; **San José-García, I.**; Karska, A.; et al., *Water in star-forming regions with Herschel (WISH). V. The physical conditions in low-mass protostellar outflows revealed by multi-transition water observations*. 2014, A&A, 572, A21
5. Karska, A.; Herpin, F.; Bruderer, S.; Goicoechea, J. R.; Herczeg, G. J.; van Dishoeck, E. F.; **San José-García, I.**; et al., *Far-infrared molecular lines from low- to high-mass star forming regions observed with Herschel*. 2014, A&A, 562, A45
6. Yıldız, U. A.; Kristensen, L. E.; van Dishoeck, E. F.; **San José-García, I.**; Karska, A.; Harsono, D.; et al., *High-J CO survey of low-mass protostars observed with Herschel-HIFI*. 2013, A&A, 556, A89
7. Kristensen, L. E.; van Dishoeck, E. F.; Bergin, E. A.; Visser, R.; Yıldız, U. A.; **San José-García, I.**; et al., *Water in star-forming regions with Herschel (WISH). II. Evolution of 557 GHz  $I_{10-101}$  emission in low-mass protostars*. 2012, A&A, 542, A8

## 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<sub>2</sub>O and CO from the WILL and Cygnus samples*. To be submitted (chapter 5 of this thesis)

## Conference Proceedings

1. **San José-García, I.**; Mottram, J. C.; Kristensen, L. E.; van Dishoeck, E. F.; Yıldız, U. A., *High-J CO lines from low- to high-mass YSOs: the dynamics of protostellar envelopes*. PPVI, B079S (2013)
2. **San José-García, I.**; Kristensen, L. E.; Yıldız, U. A.; van Dishoeck, E. F.; and *Herschel WISH Team*, *Linking high-J CO emission from low- to high-mass protostars with Herschel-HIFI*. IAU Symposium 280, Poster 74, Session 1 (2011)



# Curriculum Vitae

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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 Valencia*. 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<sub>2</sub> 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

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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.

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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, Vachail (¡buena 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!), Daaaaaaan (*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*

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