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## Thesis subject

Name of the laboratory: Laboratoire d'Astrophysique de Marseille

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Co-advisor:

Subject's title: Astrochemistry of high-redshift galaxies

Subject description:

The goal of this PhD is to understand how the physico-chemistry of the interstellar medium has evolved over scales of several billion years. To go back in time and understand this evolution, we propose to model the abundances of atomic and molecular species, as well as their emission spectra. The emission lines of these tracers can be compared with the spectra that can be observed in red-shifted galaxies ( $2 < z < 7$ ), these galaxies offering a wide variety of physicochemical conditions. The abundances of the different species will be calculated according to different parameters (metallicity, ionization rate, hydrogen density, dust abundance and size, stellar formation duration, stellar formation rate, ...) and their spectra will be included in the spectral energy distribution modeling and adjustment code, CIGALE, developed at LAM. The spectral energy distributions thus modeled will then be compared to the observations (Herschel-FTS, ALMA, NOEMA, ...) starting from the low  $z$  galaxies, for which we have a lot of data, to go to  $z$  galaxies more bigger, where we have a lot less data. The aim of this work is both to identify what are the robust tracers of the parameters that govern the evolution of galaxies, to understand the evolution of physico-chemistry over long time scales and to predict future observations. on the JWST, and possibly SPICA.

### Bibliography:

- CIGALE: a python Code Investigating GALaxy Emission, M. Boquien, D. Burgarella, Y. Roehly, V. Buat, L. Ciesla, D. Corre, A. K. Inoue (井上昭雄) and H. Salas, 2019, A&A, 622 A103
- Constraints on the cosmic-ray ionization rate in the  $z \sim 2.3$  lensed galaxies SMM J2135-0102 and SDP 17B from observations of  $\text{OH}^+$  and  $\text{H}_2\text{O}^+$ , Indriolo N. et al., arXiv:1808.04852v1
- $\text{HD}$  and  $\text{H}_2$  formation in low-metallicity dusty gas clouds at high redshift, S. Cazaux and M. Spaans, 2009, A&A, 496, 365

mini CV:

1999-2003: doctorat: Ecole Polytechnique Fédérale de Lausanne

2003-2005: post-doctorat Harvard-Smithsonian Center for Astrophysics

thèmes de recherche: évolution physico-chimique des galaxies

anciens/actuels doctorants

- Florent Mispeler: 2010-2013

- Istiqomah 2016-2020

- Franciele Kruczkiewicz 2019-2022

- Gayathri Gururajan 2019-2022