The impact of massive stars: from the Milky Way to nearby galaxies

Galaxies that can be seen through amateur telescopes or on popular science images seem to be made of three components: an abundant quantity of stars and planets rotating around a central black hole. Nonetheless, the major part of galaxies is made of dust and gas at a temperature close to the absolute zero (−273 °C) and invisible to our eyes. Gas and dust tend to gather into huge clouds which are the birthplace of stars. For instance, one of the most popular stellar nurseries consists of three gigantic column of dust known as "the Pillars of Creation", and became famous thanks to the Hubble Space Telescope (and lastly with JWST).
When astrophysicists study the stars in our Galaxy, they have to distinguish between low-mass and high-mass stars because their formation, evolution and death are completely different. In particular, massive stars are able, at the very beginning of their formation, to sweep-up their surroundings thanks to powerful stellar winds and to the huge quantity of ultraviolet photons they emit. This phenomenon creates a layer of material around the massive stars and the whole structure is commonly called a "bubble". What is very interesting with these bubbles is that the surrounding dense layer of material is an excellent stellar nursery where a lot of massive newborn stars can be observed.

In my research project, I propose to observe these bubbles to study their properties and understand if they can efficiently form massive stars. Since the dust and gas are invisible to our eyes, we have to use specific telescopes dedicated to the observations of the coldest regions of our Galaxy. Using the data from the Herschel space satellite, I will study several bubbles, extract all the clumps of dust and gas found at their edges, and evaluate if these bubbles have the potential to form massive stars.
I will also observe the smallest structures inside these clumps thanks to very detailed observations from the ALMA interferometer, a system of 66 antennas working together to mimic an unique telescope of more than 1 km of diameter. I will also study the magnetic field with specific instruments able to detect the polarization of the light. These observations will tell us how the layer of dust and gas found around the bubbles is fragmenting, what physical processes govern this fragmentation mechanism and how massive stars are forming by unveiling the early beginning of their evolution. We will also compare bubbles in the Milky Way with bubbles in other galaxies to broaden our knowledge on the star-formation process.

This project aims at a better understanding of the role of bubbles in the formation of high-mass stars in our Galaxy. This is particularly important because thousands of bubbles are present in all galaxies and their crucial role in promoting the formation of a new generation of massive stars may change our view of the Universe's history. Therefore, it is crucial to understand their role in the star-formation process in the global framework of galaxy evolution. Last but not least, due to the huge development of interferometry and the still unsolved question of high-mass star formation, I want, through this project, to promote the place of the National Centre for Nuclear Research (NCBJ), with a new Polish Community of students and researchers, to make it at the forefront of this promising research field.