The aim of the present grant application is to determine and analyse plasma elemental abundances for solar and solar-like star coronae based on the interpretation of their X-ray spectra. We will analyse the spectra obtained during periods of various activity levels, ranging from quiet, non-flaring states to active states, such as flares of various magnitudes. In our research, we will assume that the emitting plasma is multitemperature and in ionisation equilibrium. Under these assumptions, it is possible to determine the shape of the differential emission measure (DEM) distribution using various existing methods and based on the fluxes measured in many spectral lines (or spectral intervals). However, the model of plasma elemental composition must be defined a priori. An essential and innovative part of the present project will be the use of an approach that allows for the **simultaneous** determination of both the chemical composition of the emitting plasma and the form of the differential emission measure distribution as determined from the measured spectra.

The analysis will be carried out using one of the tools of artificial intelligence - the method of differential evolution. This novel approach was proposed by us, tested, and used to analyse flares observed with the RESIK spectrometer aboard Koronas-F (Kępa et al. 2022) and two events observed with the Solar X-ray Monitor (XSM) aboard the Chandrayaan-2 mission (Kępa et al. 2023). We plan to extend the analysis to other XSM flares and observations from NASA Chandra X-ray Observatory and ESA XMM-Newton mission, which register stellar spectra.

XSM observations, thanks to their high time and energy resolution, constitute a unique database that allows the determination not only of temperature and emission measures but above all, the abundance of as many as eight elements (magnesium, aluminium, silicon, sulphur, argon, calcium, iron, and nickel). Stellar observations provide us necessary data to study the inverse FIP (First Ionisation Potencjal) effect, which is mainly observed in stellar coronae but has also been identified in individual solar flares (Laming, 2021).

We plan to create a database (catalogue) of characteristic X-ray spectra measured at different levels of activity for the Sun and stars. This catalogue will contain information about basic calculated plasma parameters, such as average temperature and emission measure, the DEM shape, and the values of elemental abundances – how they evolve in time. This database will be publicly available via webpages.

The data on plasma elemental abundances are the basic input necessary for interpreting astrophysical spectra. They are essential for modelling physical processes in coronal plasma, including the calculation of momentary flare energy distribution, and play a pivotal role in elucidating the history of star formation and metal enrichment in stars.

Although the chemical composition of the Sun is known with better accuracy than that of other stars, the values of solar elemental abundances still have large uncertainties, especially for the structures observed in the corona. Additionally, the determination of chemical composition depends on the method used for the analysis and on the approximation describing the thermal model of the emitting plasma (isothermal or multithermal plasma). This will be studied and differences explained within the proposed investigation.

Our algorithm constitutes a completely new approach to tackle the problem of determining elemental abundances and DEM. The results of this research will upgrade our knowledge of the chemical composition of the Sun and other stars and allow us to check the possible dependence of composition on other physical characteristics of the coronal sources.