General audience project summary:

Timber has been used by humankind for thousands of years. Despite such long-standing connection with this material we know very little about its molecular structure. The proposed project is looking to study the very basic process of variation in wood properties that gives rise to formation of so called “tree rings”. Each year, in the spring, trees produce timber known as earlywood which is characterised by light colouration due to presence of thin walls surrounding each wood cell. In the summer, trees produce latewood which is characterised by darker colouration and presence of thicker walls surrounding each wood cell. Despite obvious visual differences, both earlywood and latewood are made mainly from cell walls which are a mixture of linked chains of long sugar molecules, polysaccharides, and hydrophobic compounds, lignin, that make wood impermeable to water. Despite the importance of timber we know very little about the exact molecular structure of these wood building blocks and the way the environment influences the transition process between earlywood and latewood.

The project will study the differences in the properties and structure of polysaccharides that make earlywood and latewood. The work will look to understand to what extent, and how, these differences lead to variation with respect to resistance of timber to enzymatic processing which is a key step in its sustainable industrial application. To understand the assembly of wood building blocks the project will use, in collaboration with the University of Cambridge, low temperature electron microscopy to visualise the structure of wood. Moreover, the project will analyse the impact of day-length, light intensity and composition on the process of earlywood to latewood transition. The experiments will study how changes in the length of the day, the quality of light and the amount of light energy supplied can be used to control the wood formation process.

The increase in the global population and the process of climate change necessitate the development of novel, sustainable, bio-based economy. As the majority of carbon in terrestrial ecosystems is stored in forests as wood the material offers an unprecedented renewable resource of energy and biodegradable materials. As such, wood derived products can contribute some solutions to challenges associated with, for example, fossil fuels and plastics pollution. Variation in wood properties and lack of understanding of their origin is one of the main challenges in the development of novel applications of wood. By studying the molecular structure of timber the work may unravel the reasons for the variability between earlywood and latewood. In addition to that, by understanding the importance of light signals perceived by trees for the transition process between the formation of two types of wood we might be able to inform future forestry practices looking to generate desired types of timber. Moreover, our basic research will directly contribute to the advancement of knowledge in the plant developmental biology by potentially providing particularly important information connecting environmental signals with the molecular structure of timber produced by trees.