Most solid materials would produce nothing of significance if squeezed or if subjected to mechanical stress. However, a special class of materials responds in a spectacular way, as it generates an electrical charge that can be harvested to create a wide range of applications. Such materials are known as piezoelectrics, with the origin of the word "piezo" meaning "to squeeze". Relaxor ferroelectrics, a particularly important subclass of piezoelectrics, are notable for the strong coupling they exhibit between external physical stress and electrical polarization or the electrical charge they produce. This property makes them extremely useful for making devices that detect sound, position objects with ultrahigh precision, or even harvest electrical energy from common motion.

Despite the fact that relaxor ferroelectrics have successfully found their way into common and more advanced specialty applications, the exact physical mechanisms leading to their amazing properties remain poorly understood. Learning more about their atomic structure at various scales would allow chemists and physicists alike to better understand why these materials behave the way they do and to ultimately design and develop better, safer and more effective alternatives. Our work uses newly developed state-of-the-art x-ray and neutron scattering techniques to examine how certain atoms within the relaxor ferroelectric materials are positioned with respect to other atomic species. Contrary to current theory, we find that competition between the different ways of how the atoms arrange themselves is behind piezoelectricity in these materials. Moreover, we find that both light and heavy atoms contribute to the piezoelectricity. Depending on a delicate choice of chemical components, relaxor ferroelectric candidate materials can be made highly ordered or highly frustrated or both; strong piezoelectricity comes at a balance of these two extremes.