Local structure probes for identifying dual orbital degeneracy lifting in a strongly correlated electron system
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The local structure of NaTiSi$_2$O$_6$ is examined across its Ti-dimerization orbital-assisted Peierls transition at 210 K. X-ray atomic pair distribution function analysis demonstrates the existence of local symmetry breaking pre-existing far above the transition. The results show that the low-temperature dimers evolve on heating into a short-range orbital degeneracy lifted (ODL)[1] state of dual orbital character, with evidence of their existence persisting up to at least 490 K. The ODL state is correlated over the length scale spanning ~6 sites of the Ti zigzag chains. Our results imply that the ODL phenomenology extends to strongly correlated electron systems.