Criminal minerals: Investigating minerals that break the laws (of clasical crystallography)

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CRIMINAL MINERALS: INVESTIGATING MINERALS THAT BREAK THE LAWS (OF CLASSICAL CRYSTALLOGRAPHY)

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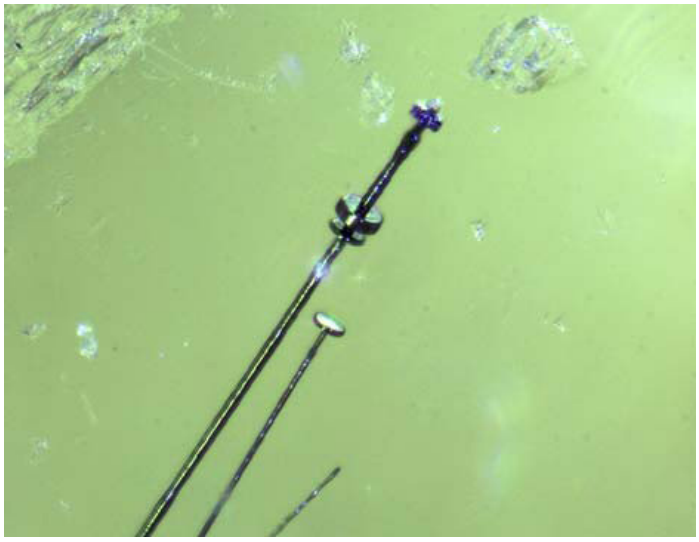
The laws of classical crystallography are well established for hundreds of years and have been immensely successful in science and technology. The foundational law of crystallography, from which others follow, has been that a crystal must possess a periodic translational order, or symmetry, in the way its atoms are arranged in space. Simple!

As naturally occurring crystalline materials, minerals are subject to these laws too. But lots of things can go wrong when a crystal grows, thanks to entropy and countless complicating factors provided by dynamic geological contexts. As such, minerals break the laws of crystallography routinely, although one might consider many of them minor infractions, with things like impurities, some law-breaking habits even lead to what collectors find desirable- like twinning.

Some old, and especially some newer minerals are simply incorrigible, however, with broken periodic translational symmetry an inherent and inescapable part of their very natures. Despite classical crystallography's successes, atoms will do what nature allows!

After reviewing the laws of classical crystallography and some of their implications, this talk will then illustrate, using a variety of examples of parked cars, a spectrum of mineralogical lawbreakers. These ranging from minor infractions (impurities and defects), to repeat offenders (twins), to the incorrigible- which in fact lack the periodic translation order that defines what a crystal is. Familiar examples of incorrigible minerals include calaverite, franckeite, cylindrite, and merelaniite. Modern X-ray diffraction detectors continue to uncover more examples, as these intrinsic law-breakers still give sharp X-ray diffraction patterns- something that was thought to be possible only in crystals with periodic translational order. Finally, a class of lawbreakers known as quasicrystals, which have quasiperiodic rather than periodic translational order, are now represented in the mineral kingdom, and spectacularly reveal their criminal nature by manifesting crystallographically forbidden 5-fold (icosahedrite) and 10-fold (decagonoite) rotational symmetries.



Cylindrical whiskers of merelaniite in diopside, from the Merelani tanzanite mines, Manyara Region, Tanzania. Like its cousin cylindrite, merelaniite lacks the three-dimensional periodic translational symmetry of a crystal. The longest whisker section in this frame is 0.5-mm long.