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Anomalous weak values without post-selection

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A weak measurement performed on a pre- and post-selected quantum system can result in an average value that lies outside of the observable's spectrum. This effect, usually referred to as an "anomalous weak value", is generally believed to be possible only when a non-trivial post-selection is performed, i.e., when only a particular subset of the data is considered. In this work we show, however, that this is not the case in general: in scenarios in which several weak measurements are sequentially performed, an anomalous weak value can be obtained without post-selection, i.e., without discarding any data. We discuss several questions that this raises about the subtle relation between weak values and pointer positions for sequential weak measurements. Finally, we consider some implications of our results for the problem of distinguishing different causal structures.

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