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The meaning of negative weak values JAMES TROUPE, JEFF TOLLAKSEN, George Mason University — A number of approaches to quantum mechanics incorporate negative values for quantities that were classically positive, such as the Wigner-Moyal density approach or the Feynman negative probability approach, etc. In the re-formulation of quantum mechanics using weak values and weak measurements, we encounter a new situation where weak values of projection operators turn out to be negative. We emphasize the differences between these negative weak values and the negative values encountered in the other formalisms: in the previous formalisms, the mathematical entity whose average yielded the negative values are not density operators. While they do yield the correct average of a function, they also have non-physical aspects, i.e. mathematical artifacts, when the densities become negative. The reason is that if we attempt to actually measure such "negative" properties, then the result does not correspond to a physical observable in Hilbert Space. E.g. if we did attempt to cheat quantum mechanics by projecting onto p and x as densities simultaneously in Wigner-Moyal, then we obtain the parity operator, the most non-local result. On the other hand, in the case of weak values, we obtain a new situation: when we use a bonafide measuring device to measure these properties ideally, then the very same measuring device will yield the predicted negative weak values when the measurement interaction is simply weakened.

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