Deconstructing the spin susceptibility of a cuprate superconductor

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A major obstacle to understanding high-T_c cuprates is that superconductivity precludes observing normal-state properties at low temperatures. One prime example is the normal-state spin susceptibility χ_{spin}: although its decrease upon cooling far above T_c typifies pseudogap behavior, its behavior at lower temperatures is generally unknown. Our measurements expose χ_{spin} of $YBa_2Cu_3O_y$ down to low temperatures by suppressing superconductivity in high magnetic fields. We uncover a residual $\chi_{spin}(T=0)$ due to gapless excitations along with two distinct, thermally-activated contributions that depend upon hole doping. These results lead us to propose that the pseudogap in χ_{spin} is, in fact, a composite property contributed by different phenomena. Besides short-lived antiferromagnetism at high temperatures, we identify two low-temperature contributors: gapped spin-singlets similar to those found in certain quantum spin systems and the short-range charge-density wave.