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A short, generalizable, and q-analogizable proof of Meshalkin's generalization of Sperner's theorem on componentwise antichains

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We study classes of ordered partitions into p parts of an n -element set, in which for each k the family of k -th parts is an antichain (that is, a family of sets in which there are no subset relations). Meshalkin's theorem, a generalization of Sperner's Theorem, states that the maximum size of such a class is the maximum size of a multinomial coefficient $\binom{n}{a_1, \dots, a_p}$. We generalize this and a stronger inequality called an LYM inequality. Our proof is simpler as well as more general than all previous proofs and extends to analogous statements—with a twist—about flats in a projective geometry.

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