

**FREE NESTED CUMULANTS AND AN ANALOGUE OF A FORMULA OF
BRILLINGER**

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Abstract: We prove a free analogue of Brillinger’s formula (sometimes called “law of total cumulance”) which expresses classical cumulants in terms of conditioned cumulants. As expected, the formula is obtained by replacing the lattice of set partitions by the lattice of noncrossing set partitions and using an appropriate notion of noncommutative nested products. As an application we reprove a characterization of freeness due to Nica, Shlyakhtenko, and Speicher by Möbius inversion techniques, without recourse to the Fock space model for free random variables.

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