I. INTRODUCTION

Both the Fermi breakup (FBM) and the statistical multifragmentation (SMM) models provide prescriptions for calculating mass and charge distributions and multiplicities of the fragments emitted in the breakup of an excited nuclear system. Yet they would seem to be very different models. They are formulated in diferent terms and usually applied in very different regions of mass and excitation energy. We will show that they are much more closely related than they might appear to be at first glance.

The FBM was originally proposed as a means of calculating the multiplicities[1] and angular distributions[2] of pions and antiprotons produced in high-energy collisions of cosmic-ray protons with nucleons in the atmosphere. It was found to be quite successful in this respect[3]. It was later applied to the statistical decay of light fragments of proton-induced spallation reactions[4–6] and is now included as the preferred option for the equilibrium statistical decay of light fragments in widely-used nuclear reaction/transport codes, such as FLUKA[7] and GEANT4[8]. A variant called the phase space model, which partially takes incomplete equilibration into account, plays an important role in the analysis of experimental multi-particle fragmentation spectra in light-ion reactions[9–13]. In the context of nuclear reactions, the FBM usually assumes that fragments are emitted in their ground states or in (almost) particle-stable excited states and is formulated directly in terms of a phase-space integral limited only by the constraints of linear momentum and energy conservation.

The SMM is used to describe the decay of highly-excited fragments of heavy-ion or spallation reactions. It assumes thermal equilibrium and thus allows for the emission of particle-unstable excited fragments consistent with that equilibrium. It has been widely compared to experimental data and found to reproduce them reasonably well[14–17]. Although many versions of the SMM have been proposed over the years[18–26], it was first developed systematically in Refs. 18–20. The SMM is normally formulated in terms of a statistical partition function, be it microcanonical, canonical or grand canonical. The most appropriate of these is the microcanonical partition function, for which charge, mass number and energy are strictly conserved. The canonical and grand canonical partition functions are useful for deriving analytical or semi-analytical expressions that would be impossible to obtain in the microcanonical formulation or, when fluctuations are small, to simplify calculations.