

## 5.4 The micro-canonical, canonical, and the grand-canonical ensemble

The macro state has to be considered by its restrictions.

micro restrictions	macro restrictions
Each system of the ensemble, even each micro state fulfills the restriction	Only on average the ensemble fulfills the restriction
e.g. $U_i = U$	e.g. $\sum_i p_i U_i = U$

For large systems ( $N \gg 1$ ) micro- and macro restrictions do not differ in their physical properties.

Kind of ensemble	micro restriction	macro restrictions	macro restrictions
	Average only of systems with identical values of:	variable values for averaging	averages
micro canonical ensemble	$V, N, U$	— — —	— — —
canonical ensemble	$V, N$	$U_i$	$U = \sum_i p_i U_i$
grand canonical ensemble	$V$	$U_i$ $N_i$	$U = \sum_i p_i U_i$ $N = \sum_i p_i N_i$

These ensembles correspond to different thermodynamic contacts.

Which ensemble we use for the calculation is just a question of convenience.