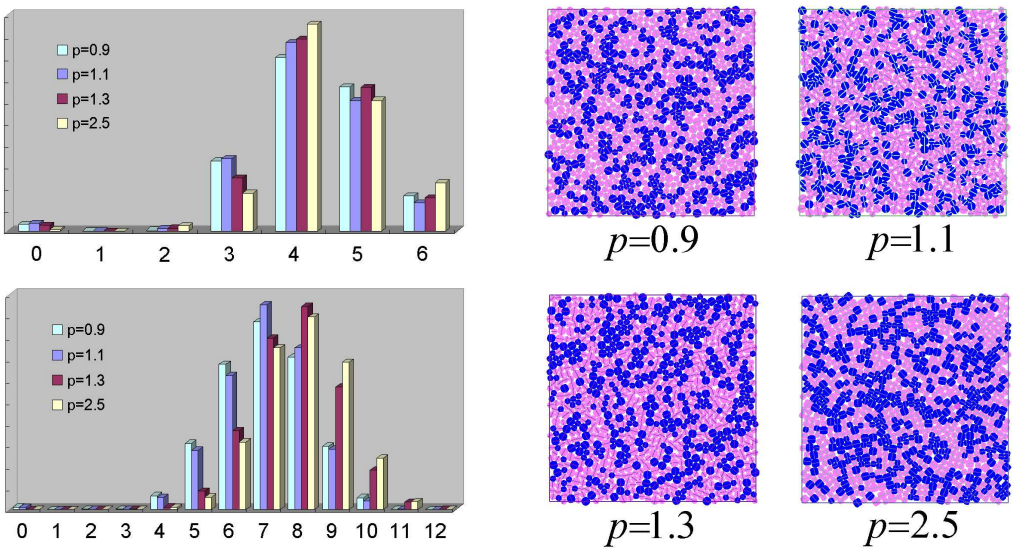


(a) (b)

FIG. 7: (color online). (a) Distribution of contact numbers for different $p$ values for MRJ packings of superdisks (upper panel) and superballs (lower panel). (b) Local packing structures with more contacts than average (shown in blue) and those with less contacts than average (shown in pink) in two-dimensional superdisk packings for different $p$ values.

### C. Hypostaticity and Nongeneric Local Structures

There have been conjectures [15, 16] that frictionless random packings have just enough constraints to completely statically define the system (i.e., it is *isostatic*), i.e., for large packings, one has $Z = 2f$. It has been shown both experimentally and computationally that although the isostatic conjecture [15] holds for large sphere packings [40, 44], it is generally not applicable to nonspherical particles, such as ellipsoids [31, 32]. It was found that even for ellipsoids with large aspect ratios, $Z$ is still slightly below $2f$ [31].

Here we observe that in MRJ packings of superdisks and superballs $Z$ is significantly smaller than $2f$ for all values of $p$ examined, i.e., the packings are significantly *hypostatic*. The hypostatic packings result from the competition between $f_T$ translational and $f_R$ rotational degrees of freedom of the particles ($f = f_R + f_T$) in developing the contacting networks close to the jamming point. In particular, although it is true that to constrain the translational degrees of freedom each particle needs at least $2f_T$ contacts, rotational degrees of freedom can be blocked with less than $2f_R$ additional contacts per particle if