

**Title:** Phase diagrams of binary mixtures of patchy colloids with distinct numbers and types of patches: The empty fluid regime

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**Abstract:** We investigate the effect of distinct bonding energies on the onset of criticality of low functionality fluid mixtures. We focus on mixtures of particles with two and three patches as this includes the mixture where "empty" fluids were originally reported. In addition to the number of patches, these species differ in the type of patches or bonding sites. For simplicity, we consider that the patches on each species are identical: one species has three patches of type A and the other has two patches of type B. We have found a rich phase behavior with closed miscibility gaps, liquid-liquid demixing, and negative azeotropes. Liquid-liquid demixing was found to pre-empt the "empty" fluid regime, of these mixtures, when the AB bonds are weaker than the AA or BB bonds. By contrast, mixtures in this class exhibit "empty" fluid behavior when the AB bonds are stronger than at least one of the other two. Mixtures with bonding energies  $\epsilon(BB) = \epsilon(AB)$  and  $\epsilon(AA) < \epsilon(BB)$ , were found to exhibit an unusual negative azeotrope. (C) 2011 American Institute of Physics. [doi:10.1063/1.3561396]

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