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Right unitarity triangles and tri-bimaximal mixing

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We propose new classes of models which predict both tri-bimaximal lepton mixing and a right-angled CKM unitarity triangle, α approximately 90 degrees. The ingredients of the models include a supersymmetric unified gauge group such as SU(5), a discrete family symmetry such as A4 or S4, a shaping symmetry including products of Z2 and Z4 groups as well as spontaneous CP violation. We show how the vacuum alignment in such models allows a simple explanation of α approximately 90 degrees by a combination of purely real or purely imaginary vacuum expectation values of the flavons responsible for family symmetry breaking. This leads to quark mass matrices with 1-3 texture zeros that satisfy the phase sum rule and lepton mass matrices that satisfy the lepton mixing sum rule together with a new prediction that the leptonic CP violating oscillation phase is close to either 0, 90, 180, or 270 degrees depending on the model, with neutrino masses being purely real (no complex Majorana phases). This leads to the possibility of having right-angled unitarity triangles in both the quark and lepton sectors.

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