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Preferred sunspot longitudes: Non-axisymmetry and differential rotation

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It was recently shown by Berdyugina & Usoskin (2003) that the distribution of sunspots is non-axisymmetric and that spot groups form preferably near two persistent active longitudes separated by 180°. Here we quantitatively study the non-axisymmetry of sunspot occurrence and introduce a dynamic reference frame inferred from the differential rotation law. In such a frame the raw sunspot data shows a clear clustering around the persistent active longitudes. The differential rotation describing the dynamic frame is quantified in terms of the equatorial rotation rate and the differential rotation rate, which appear to be significantly different from that for individual spots. This implies that the active longitudes are not linked to the depth of sunspot anchoring. We introduce a quantitative measure of the non-axisymmetry in sunspot occurrence. The non-axisymmetric mode was found to be highly significant, and its ratio to the axisymmetric mode is roughly 1:5. This puts constrains on solar dynamo models.