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Solar grand and super-grand cycles derived with PCA from the solar background magnetic field

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We present principal components analysis (PCA) of temporal magnetic field variations over the solar cycles 21-24. These PCs reveal two main magnetic waves with close frequencies (covering 40$\%$ of data variance) travelling from the opposite hemispheres with an increasing phase shift. Extrapolation of these PCs through their summary curve backward for 2000 years reveals a number of $\sim$350-year grand cycles and about 2000 super-grand cycles superimposed on 22 year-cycles with the features showing a remarkable resemblance to sunspot activity reported in the past. The summary curve calculated forward for the next millennium predicts further three grand cycles with the closest grand minimum occurring in the forthcoming cycles 25-27 when the two magnetic field waves have a phase shift of 11 years. We explore a role of other independent components derived with PCA and their expected effects on the resulting summary curve, or solar activity curve. We suggest that these grand and super-grand cycles can be produced by two dynamo waves generated in different layers with close frequencies whose interaction leads to beating effects that is discussed in the work by Popova et al (2016) presented here. This approach opens a new era in investigation and prediction of solar activity on long-term timescales.