Spin Echo in Synchrotrons

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As a polarized beam is accelerated through a depolarization resonance, its polarization is reduced by the well-known Froissart-Stora factor. When the beam subsequently crosses a second resonance, the final beam polarization is considered to be reduced by the product of the two Froissart-Stora factors, each computed independently of the other. This is a good approximation when the spread of spin precession frequency $\Delta\nu_{spin}$ (particularly due to its energy spread) of the beam smears out any memory of precession-phase information during the time τ between the two crossings.

When τ is too short to complete the smearing process, an interference effect occurs. The final polarization will exhibit constructive or destructive patterns according to the exact values of τ and $\Delta\nu_{spin}$. Typically, the beam's energy spread is large and this interference effect does not occur. To study this effect, therefore, it is necessary to reduce the beam energy spread and to consider two resonances that are very close to each other.

It is proposed here that another perhaps more curious mechanism that allows the study of interference between two resonance-crossings is spin echo. In this case, even when the precession-phase memory seems to be completely lost between the two crossings (when τ is very large), there will be a sudden and short-durationed echo signal of beam polarization at a time τ after the second crossing. This echo signal exists even when the beam has a sizable energy spread, and could be a sensitive way to experimentally test the intricate spin dynamics in a synchrotron.