# Extending the Quperceptron to Spin Systems: a Note

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**Abstract**

In this note, the author provides some thoughts on a spin-based quperceptron.

To begin, we point the interested reader to Gordon Baym's text, specifically Chapter 23 [1]. In that chapter, in the introductory section, in considering spin, Baym considers angular momentum (AM) as well as orbital angular momentum (OAM). He argues that OAM transforms as a second rank tensor and not a vector when looking at a new frame, Lorentz transformed visavis the original frame.

Taking this observation as a prop, we revisit the quantum perceptron which consisted of the motional states of N ions. We ask the question, whether we can look instead at the OAM of $N$ spin-half particles as constituting a quantum perceptron. We know, from nuclear magnetic resonance (NMR) [2], that there exist spin-spin interactions, as well as spin-bath interactions or couplings. The latter are exactly what we would need to apply the analog of the three-step environment "voltage" which was used as a control signal in the quantum perceptron [3]. Thereafter the $N$ spins are allowed to evolve and finally, there is a measurement of the type done in NMR. This is treated as the output of the spin based perceptron. If it is not a match with the expected output, then the distance between the two is fed back via the bath to the $N$ spins. The process continues, until the spin-system is trained. Thereafter, it can be tested. The Dirac equation will be relevant in the analysis of this perceptron, which will be carried out in the future.

An interesting investigation to be carried out once the equations are written down would be to address the question of a change in the frame of reference for the spin based quperceptron, and whether certain steps of the three- step learning "voltage" applied are automatically applied in a new frame, or whether there exists such a frame in which this happens. Learning could then be seen partly as a change in the frame of reference. This is often true, in human comprehension, a paradigm shift leads to understanding which is concomitant with learning.

## References


[1] Gordon Baym. *Lectures on quantum mechanics*. CRC Press, 2018.

[2] Mark A Nanny, Roger A Minear, and Jerry A Leenheer. *Nuclear magnetic resonance spectroscopy in environmental chemistry*. Oxford University Press, 1997.

[3] Aman Chawla. Quantum perceptrons and evolution. March 2024.