Stern Gerlach experiment modelled Classically with Net Translational Magnetic force.

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Abstract

In the original 1922 Stern Gerlach experiment the single horizontally propagating incident beam was split into two 'up' or 'down' diverging beams. An observation not consistent with predictions of the time which were that the path deflection angles in a classical model should be deflected up or down in only an even range of angles. Here it is proposed that net translational forces on a dipole in an inhomogeneous field can correctly model the observed split paths for a classical model. In that the dipoles will initially experience a range of very small path deflections via the up or down net translational forces on them as they enter the apparatus. A deflection force dependent upon the specific angle of the N-S axis of polarity of each incident dipole relative to the applied external N-S field in the apparatus. This separation of the beam into 2 paths, one up and one down is effectively a classical version of the "space quantisation" often referred to in QT. After entering the field, the dipoles will then have been sorted into two up and down paths as well as each path having a range of these very small different angled path deflections from the horizontal incident path. They will then all each experience an additional amount of net translational forces applied equally on all aligned dipoles as they propagate through the 3.2 cm length of the external field. Separating the 2 up and down sets into two distinct paths.

Introduction

Spin is a theoretical construct that seems to be preventing Quantum theorists from finding simpler solutions to experiments based on classical models only. Here it is proposed that if atoms are treated as magnetic dipoles subject to inhomogeneous magnetic fields, then the Stern Gerlach experiment can be explained sufficiently by a classical model.

We know in the experiment that the incident beam must consist of all angles of dipole polarisations. And so it follows that statistically this must be a 50/50 split. That is half must have their N pole facing up from any angle between horizontal to perpendicular to the beam path. And the other half must have the same range of angles between 0-90 degrees but all with their N pole facing down. And we know separately from experimental observations that a dipole will be repelled if its N pole faces towards the N pole of an external field. Or attracted if its S pole faces the external field's N Pole. Implying that in a classical model, as it is also expected to do in QT, half of the dipoles will be initially deflected upwards in a range of angles by the external field. And half deflected downwards. Separately there is also a statistical preference for a greater number of dipoles with their N-S dipoles fields facing parallel to the direction of motion of the dipole in a beam.

In accordance with well accepted classical models of net force on dipoles in inhomogeneous fields each atom in the incident beam will experience a path deflection upon entering an inhomogeneous magnetic field depending on each incident atom's dipole field angle relative to the external field. This path deflection is proportional to the net translational force imposed on the dipole by the inhomogeneous external field of the S -G apparatus. As illustrated in Fig 1, a dipole whose field angle is closest to perpendicular to the inhomogeneous field will receive the least net force. And a dipole oriented with its field parallel to the external field will receive the greatest net up or down force. It is at this moment of entry into the external magnetic field of the apparatus that this range of positive or negative deflections on the dipole paths are effected. And once inside the field, all dipole fields are now aligned N-S with the external field. From which point on a net translational force is then applied equally to all the now aligned dipoles as they pass through the 3.2 cm length of the inhomogeneous magnetic field part of the apparatus. A net up or down translational force which pulls the two "quantised" north south beams of dipoles farther and farther apart in curved paths. With each dipole receiving the same amount of net force up or down as all of the other dipoles. Illustrated in Fig 1 as the curved paths showing the effect of the constant up or down net translational forces on the moving dipoles. This net force eventually separates the beam into 2 North and south paths at the image plane. As is observed in the original S-G experiment. This initial up down range of path splitting of the deflected beams atoms based on incident dipole angles is essentially what is usually referred to as space quantisation in QT.

Separately, it is worth pointing out here that currently no published experiments showing the multiple beam paths predicted for other elements in a S-G apparatus and predicted by Quantum theory has ever been successfully completed. All available reference show that all single element S-G style tests always gave only the same double humped split paths in the image plane as the silver atoms did in the original experiment. Casting serious doubts over the validity of Quantum theory and its failed 'space quantisation' multi path predictions for atomic elements other than silver.

Quantisation into Positive or negative paths in a classical model

It is important here to explain in more detail how the beam splitting can be explained classically. In that the even spread of angles of dipole fields in the experiment, as predicted by a Classical model in 1922, can still be made consistent with the observed split paths at the image plane without invoking space quantisation. The answer lies in the fact that after the dipoles have upon entry aligned themselves with the external field, the net translational force up or down on a dipole will be constant for all dipoles travelling in the horizontal beam equally as they pass through the rest of the 3.2 cm of external N-S field. Which means that all angles of paths with up (down) directions will now be pulled up (down) additionally by the same amount of force away from their original horizontal path. Take for example a dipole whose path angle away from the horizontal after entering the field will have been deflected upwards by a very small path deviation of an angle of only 0.00000001 degrees. If one calculates what path deflection that would give after travelling 3.2 cm it would not be measurable. This is also close enough to be statistically considered as zero dipoles in the beam at this angle for the purposes of modelling the experiment. But after it travels through the 3.2 cm of the beam this aligned dipole will also have been subjected to a total additional amount of net up translational force from the external field. And that total would have deflected the dipole up by an additional angle to its path to become measurable. That amount in the Stern Gerlach experiment was observed to be between a 0.1mm to 0.2mm path shift from the original horizontal path. Effectively creating the atom free empty middle band in the image plane in a classical model.

Stage 2 and 3 deflection paths modelled classically

To make stages 2 and 3 also consistent with a classical model one can then assume that after stage 1 as outlined above, all the silver atoms polarities have field directions that match the inhomogeneous field of stage 1. When travelling through the stage 2 inhomogeneous field, which is also in the same magnetic field orientation as stage 1, no splitting of the beam will occur in stage 2. As the beam of silver atoms polarities are now lined up with both the stage 1 and 2 external fields. The beam will only be deflected up towards the stronger N pole of the external field due to net translational forces on each dipole in the beam. And proceed as a single deflected beam to stage 3. In stage 3 the dipole alignment process resets and starts over again to repeat the same splitting process as seen in stage 1. Because the beam entering stage 3 has all its atoms polarities in the beam now aligned at right angles to the applied inhomogeneous field in stage 3. And therefore, all dipoles will have to have their polarities rotated and deflected up or down so as to be re-aligned again to the stage 3 external field. Unfortunately, this purely classical effect seen in stages 2 and 3 is also often misinterpreted in QT as space quantisation.

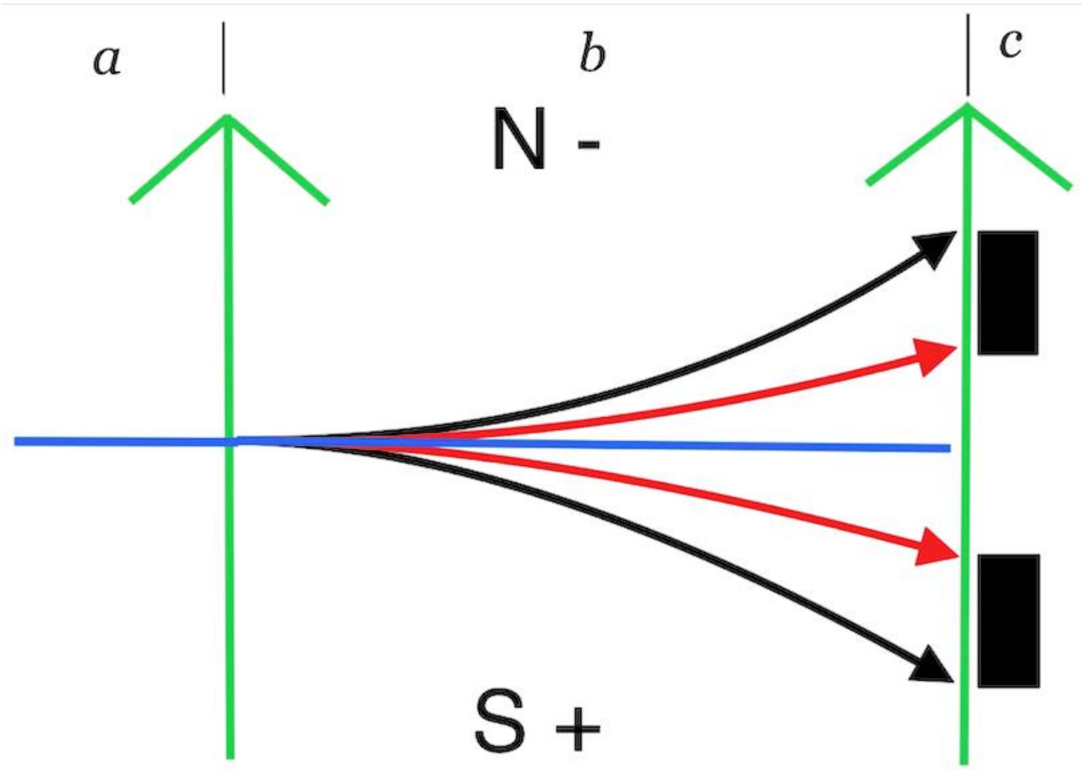

Fig 1

This illustration shows a schematic for the total path ranges of all incident dipoles. Beam paths are horizontal left to right, N-S inhomogeneous field is vertical. ***a*** *is the pre-entry incident beam composed of randomly polarised dipoles,* ***b*** *is beam path inside the inhomogeneous field with all dipole polarities now aligned with the external inhomogeneous field and* ***c*** *is beam path after exiting external field and arriving at image plane as a double path shown by the two black boxes. The blue line indicates the original incident beam path if no external field were applied. Red lines are the minimum amount of deflection the incident atom will experience if its dipole angle is effectively zero, i.e. perpendicular to the external field lines. And black lines indicate the two maximum positive and negative path deflections the atoms will experience if their incident dipole fields are vertical or parallel to the external field lines. Notice that after the initial deflections on the randomly arranged dipole fields the inhomogeneous field's net translational force is the same for all dipole paths as they travel inside the field. Separating them from their original horizontal paths and creating the observed empty gap in the image plane between the two up and down beams.*

Summary and conclusion

Upon entry into the inhomogeneous field of the apparatus the incident dipoles experience an initial deflection proportional to the angle between the specific dipole field angle and the direction of the inhomogeneous external field. This sorts the incoming beam into two sets of paths. One up and one down. Each path has a range of deflection angles from the original beam path. Deflections which are still much too small to be measurable at the image plane in Stern Gerlach. It is important to note that at this point all the atoms have also had their dipole field angles re-aligned with the North South external field by rotational force.

What is remarkable is that Quantum theorists then and now have been unable to understand the basics of net translational magnetic effects on dipoles. In that they don't seem to realise that net force initially separates the dipoles into either up or down paths upon their entry into the external field with a range of net forces proportional to the incident dipole angles. At which point the now aligned dipoles in each set all experience the same total of net translational force from the external field as they continue on through the 3.2 cm path in the apparatus. And it is this net force which further separates the up or down sets to become observable as two separate beams at the other end of the apparatus field.

Reference

1. The Stern-Gerlach Experiment Translation of: "Der experimentelle Nachweis der Richtungsquantelung im Magnetfeld" 2023 Martin Bauer