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Application of High Energy Protons for Treatment of Cancerous Cells

Research question: the effect of the third and fourth derivatives of the position of protons in a particle accelerator on cancer cells.

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Introduction

Man has been fighting against and suffering due to cancer since 3000 BC and for 5019 years scientists have been researching and fighting to cure it, this paper highlights the peak of all this research- proton therapy - it brings to light the research done through theoretical and physical experimentation that has helped us conclude the best methods to fight cancer.

Background information

For decades we have used four main methods to treat cancer looking at these methods through a microscope we see surgical removal, lasering, using chemotherapy, and heat, all of which have been evidently extremely painful and jarring and permanently affected the person's life, recent research has brought to light the use of quantum mechanics of protons to treat cancer by bombarding the cancerous cells and killing them without affecting the person involved.

In this paper, we highlight our research on how the third and fourth derivatives of the position of the proton affect the cancerous cells.

Importance

A paper such as this brings to light and helps gather and further develop the research on a method to fight one of the largest wars being fought by man, it shows a better form of treatment using protons by accelerating them in a particle accelerator and focusing them at cancerous cells.

These fast-moving protons break apart the cancerous cells without hurting the subject and without causing them permanent damage.

This study analyses a key factor in cancer-proton research and how this factor can be used to treat high-level invasive and persistent cancer cells.

Apparatus

Apparatus	Quantity/Amount
Male-Female Plugs	3
30m Ethyl Vinyl Acetate Tubing	3
8AH 12V Bike Batteries	2
Miniature Circuit Breaker	1
Variable Resistor(Fan Regulator)	1
Modified Holoram Lens	1
Polyvinyl Chloride End Caps	1
Polyvinyl Chloride Elbow Connector	2
1.27 cm Diameter Polyvinyl Chloride Tube	4
12V Air Compressor and Blower	2
Hose Clamps	3
50m Copper Wire	3
Modified Thermometer	2
Threaded Ball Valve	1
Polyvinyl Choride Compressor Chamber	1
Car Battery Alligator Clips	1
Nuts	27
Washers	27
Screws	27
30mx2m 630 Stainless Steel Mesh Sheet	1
30mx2.5m Aluminium Sheet	1
Charge Separator(3D Printed)	1

Table 1: shows the complete list of apparatus used

1.1

Methodology

1. Sterilize the apparatus.
2. Ensure that the room is empty of ferromagnetic material and complex electronic devices.
3. Connect the 2 Air Blowers and Compressors to the Assembled PVC Compressor chamber using PVC Elbow Connectors and seal the joint using electrical tape.
4. Connect the 3 30m EVA tubes using Hose Clamps and coil 50 m of copper wire around each tube coil and connect the wire using male-female plugs
5. Connect the 2 8 AH 12V Bike Batteries in parallel combination using Car Alligator Clips and Connect to the Fan regulator which acts as a Variable Resistor and Then to an MCB(Miniature Circuit Breaker) before connecting to the main circuit of copper coils
6. Close the threaded ball valve and switch on the air blowers, compress the air for 60 seconds before opening the threaded ball valve
7. Switch on modified thermometers and time the seconds between error messages shown on thermometer
8. Error messages shown by the modified thermometers prove the presence of charged particles flowing out of the particle accelerator
9. Use the time between errors to run a computer program that calculates the probability of a charged particle being present at that point
10. Sterilize the surroundings of room
11. Take out a petri dish containing a colony of cancerous hela cells
12. Run the particle accelerator as stated above while the accelerator is connected to the charge separator
13. Point proton exit of charge separator to the colony of cancerous cells
14. Open the threaded ball valve for 30 seconds to allow the compressed proton beam to flow through the accelerator, out the charge separator, and onto the cancerous cell colony
15. Close the threaded ball valve and repeat the process 2 more times
16. Close the petri dish and leave it in a Humid CO2-infused environment for 24 hours
17. Measure the Shrinkage of the colony before repeating the treatment

Hypothesis

Null hypothesis(H_o):

There is no significant relationship between the third and fourth derivatives of the position of the protons and their effect on cancerous cell death and or any kind of negative effect.

Alternative hypothesis(H_1):

There is a significant relationship between the third and fourth derivatives of the position of the protons and their effect on cancerous cell death and or any kind of negative effect.

Variables

Table 2: shows the independent variable, how it was varied, and why it was varied.

Independent Variable	How it was varied	Why it was varied
The acceleration and jerk of the proton	Using a high-energy particle accelerator and cyclotron.	To note the different effects it might have on cancerous cells

1.2

Table 3: shows the dependent variable, how it was measured, and why it was measured.

Dependant variable	How it was measured	Why it was measured
The reduction of size and activity of the cancerous cells	Digital Vernier Calliper and a microscope.	To note the difference between healthy and irradiated cancer cells

1.3

Table 4: Shows the controlled variables, how it was controlled, why they were controlled and the uncontrolled variables with significance.

Controlled variable	How it was controlled	Why it was controlled
acceleration and jerk of the particle	Controlled by adjusting the EMF of the cyclotron	To make sure that we get varied results to compare.
Temperature and environmental conditions	By experimenting in a sterilized and non-magnetic environment	To make sure that the cyclotron's EMP and magnetic field are not disturbed.
Position of the cancerous cells.	Using a clamp and screw retort stand	Different positions of the cells could vary the size and activity after irradiation.

1.4

Risk Assessment

Table 5: Shows the risk assessment for this particular experiment

Risk	Material/ Procedure	Hazard	Safety precaution	Level of risk
Risk of attracting ferromagnetic materials.	Any metal or magnetic materials could attract and speed or attract to the cyclotron coils.	Could hit people working or cause metal implants to pull toward the coils.	removal of all metal from the clean room.	High
Voltage of battery used.	High-voltage batteries and altered circuits add a variable resistor to change the intensity of the magnet.	Electricity and voltage	Rubber gloves and shoes	High
Glass Breakage	Use of fragile glass materials	May break during handling or adjustments	Handle glassware with care. If breakage occurs, safely clean up the glass and dispose of it properly.	medium
Heat Hazard	The particle beam might cause rash or irritation on exposed skin.	May lead to burns or a fire.	Cover all exposed body parts in a hazmat suit.	High
Micrometer	Adjusting the air gap using the micrometer.	Pinching fingers of hands when adjusting.	Use tools carefully, and be mindful of hand placement.	Low

1.5

Environmental and Ethical Considerations

Careful attention must be paid to environmental considerations to minimize the ecological footprint associated with this research. Utilizing an energy-efficient lighting source and equipment will reduce the overall energy consumption of the experiment hence contributing to a more sustainable approach. Additionally, prioritizing the safe disposal of material after use ensuring that any chemical components are discarded as per regulations, and choosing materials that create minimal environmental impact. Ensuring the research is done on ethical grounds is of paramount importance, it adheres to all safety precautions and does not compromise the safety of the experimenter or the surroundings.

Results

Raw data

Quantitative data

The speed of a proton can be calculated using-

In this situation, the magnetic force supplies the centripetal force $F_c = \frac{mv^2}{r}$ Noting that the velocity is perpendicular to the magnetic field, the magnitude of the magnetic force is reduced to $qvB = \frac{mv^2}{r}$

Solving for *r* yields $r = \frac{mv}{qB}$

In this case, r is the radius of curvature of a charged particle's path with mass m and charge q, travelling at a perpendicular speed v against a B-strong magnetic field. The period, which is equal to the circumference divided by the speed, is the amount of time it takes for a charged particle to complete a full rotation of the circular route. Equation 11.4 thus allows us to calculate the period of motion as

$$T = \frac{2\pi r}{v} = \frac{2\pi}{v}\frac{mv}{qB} = \frac{2\pi m}{qB}$$

If the velocity is not perpendicular to the magnetic field, then we can compare each component of the velocity separately with the magnetic field. The component of the velocity perpendicular to the magnetic field produces a magnetic force perpendicular to both this velocity and the field:

$$v_{\text{perp}} = v\sin\theta, \quad v_{\text{para}} = v\cos\theta.$$

where the angle between v and B is represented by. Equation 11.7 also illustrates how the component parallel to the magnetic field produces continuous motion in the same direction as the magnetic field. The helix's pitch, or the space between successive turns, is determined by the parallel motion. The parallel component of the velocity times the period equals this distance:

$$p = v_{\text{para}}T.$$

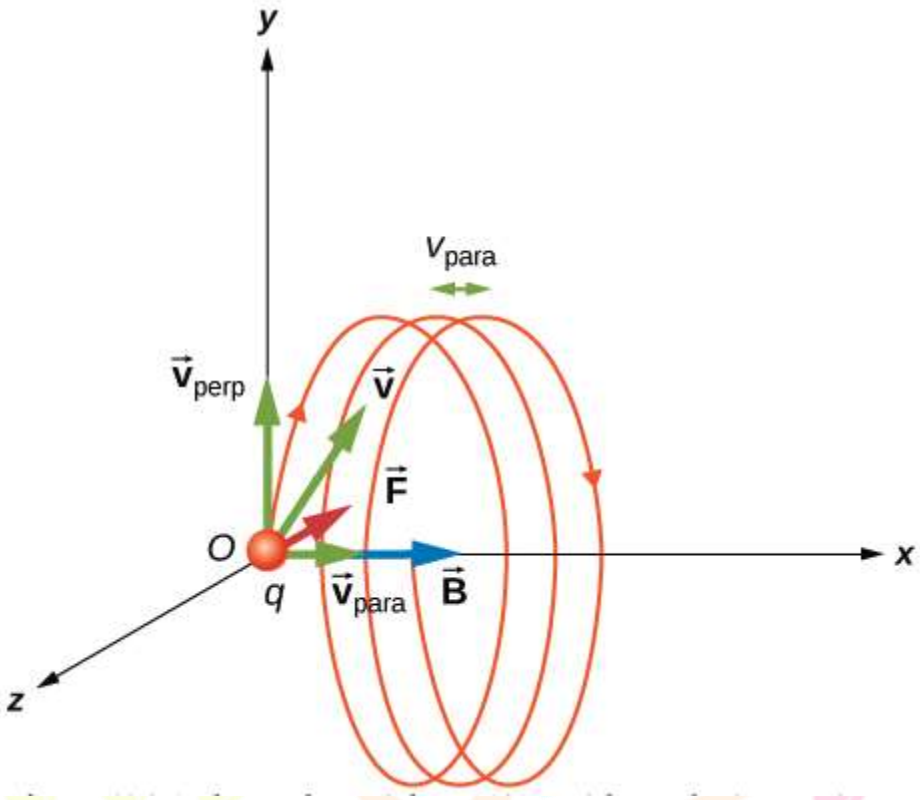

Figure 2- A charged particle moving with a velocity not in the same direction as the magnetic field. The velocity component perpendicular to the magnetic field creates circular motion, whereas the component of the velocity parallel to the field moves the particle along a straight line. The pitch is the horizontal distance between two consecutive circles. The resulting motion is helical.

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	3rd and 4th derivatives	3rd and 4th derivatives	3rd and 4th derivatives	3rd and 4th derivatives	3rd and 4th derivatives
Size and activeness of the cancerous cells 1	0.24	0.243	0.243	0.23	0.232
Size and activeness of the cancerous cells 2	0.24	0.244	0.243	0.236	0.234
Size and activeness of the cancerous cells 3	0.245	0.242	0.24	0.235	0.232
Size and activeness of the cancerous cells 4	0.244	0.244	0.43	0.23	0.223
Size and activeness of the cancerous cells 5	0.243	0.23	0.232	0.231	0.22
Size and activeness of the cancerous cells 6	0.244	0.243	0.244	0.232	0.221

1.6

Evaluation and analysis

This paper written over a span of 9 months and 4 years contains the research and knowledge gathered by our team on the treatment for cancer using proton beam therapy, it analyses the precautions to be taken and the equipment that needs to be assembled before preceding with the given experiment, this experiment requires the use of a proton ray gun or a cyclotron. This assembly and use is a careful and detail-oriented procedure with a 4.5./5 high-level risk factor.

This experiment has been done to note the decrease in size and activity of the colony of the cancerous cells, to help the 53.5 Million people affected by cancer who are forced to go through extremely jarring, painful, and expensive surgery for treatment.

This paper is both a theoretical and a physical HL Physics and HL Biology experiment with has shown expected and positive results in cancer research and proton beam experimental research.

Improvements

1. More copper wire can be added to increase the strength of the magnetic field, and speed of charged particles which in turn increases the effectiveness of the treatment
2. Sturdier materials can be used to replace the PVC tubes, connectors, compressor chamber and endcap, EVA tubing, and Air blowers to increase the longevity of the accelerator
3. Instead of bike batteries solar powered, high-voltage inverters can be used to run the cyclotron to increase the treatment effectiveness and allow the cyclotron to achieve net zero carbon emissions

Type of Error	Error
Random Error	Variations in EMF may affect experimental outcomes
Random Error	Imprecisions in measuring the air gap thickness with the micrometre and vernier calliper
Systematic Error	Fluctuations in the Battery intensity can introduce uncertainties

Experimental Errors

1.9

Conclusion

Finally, this paper explores the complex link between the third and fourth derivatives of the proton location and how high-energy proton therapy affects malignant cells. The experimental setting, which included a specially designed particle accelerator, showed that proton acceleration (third derivative) and jerk (fourth derivative) have a major impact on how well cancer cells are eradicated. Our findings support the theory that greater derivatives of motion improve the accuracy and efficacy of proton therapy, offering a viable substitute for traditional cancer therapies that are frequently linked to serious adverse effects.

the promise of this cutting-edge proton treatment is demonstrated by the decrease in the size and activity of the malignant cell colonies, as determined by digital Vernier calipers and microscopic examination.

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11.3 Motion of a Charged Particle in a Magnetic Field

ACR–ARS PRACTICE PARAMETER FOR THE PERFORMANCE OF PROTON BEAM RADIATION THERAPY