

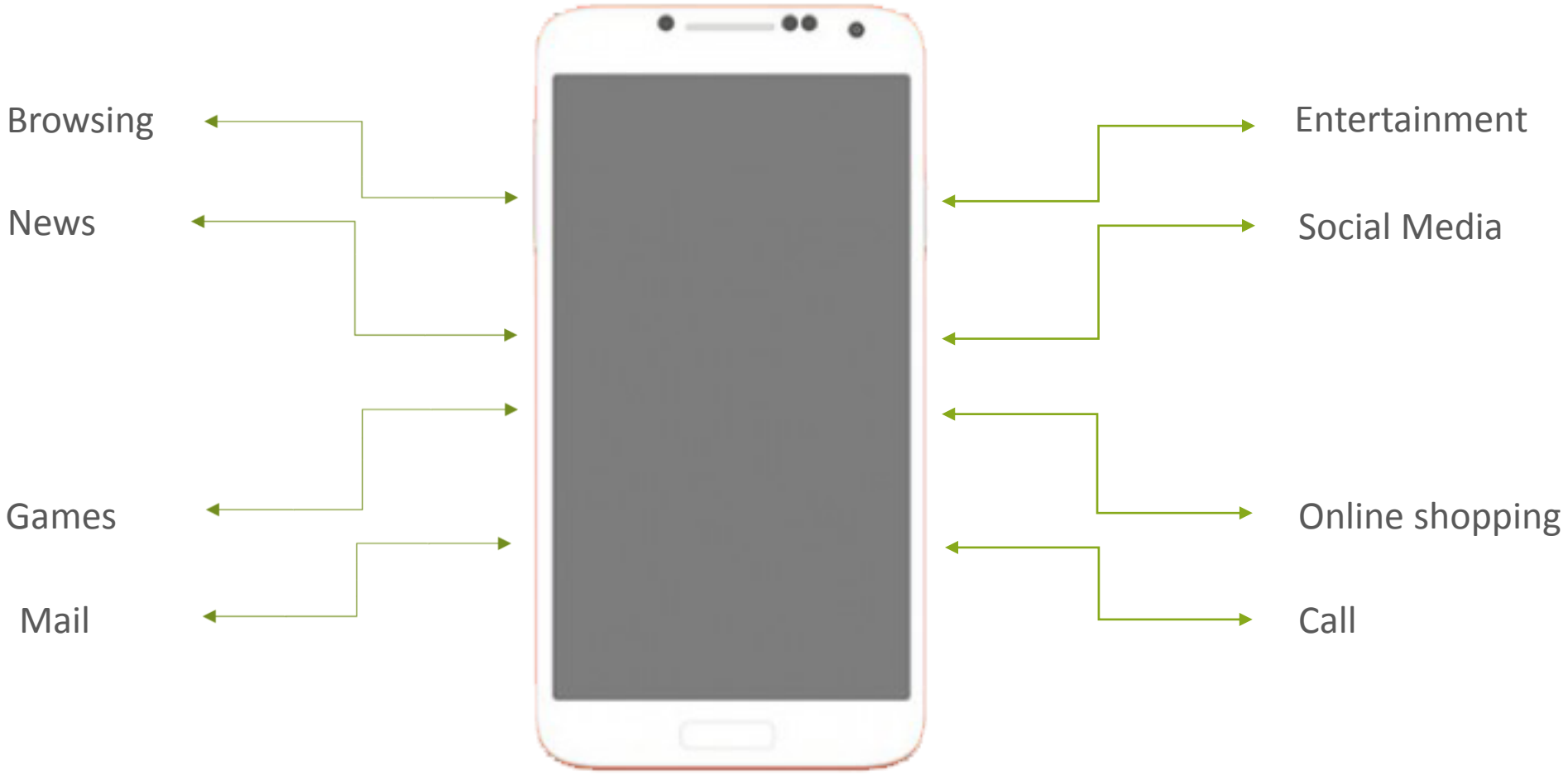
SMARTPHONE SENSORS USED TO ANALYZE A VERTICAL PENDULUM

SMARTPHONES CAN DO MORE THAN WE KNOW

IN THIS PRESENTATION WE WILL…

- Have an overview of sensors of smartphones.
- Understand how they work.
- Share our work with you.
- Learn the importance of understanding in real world.

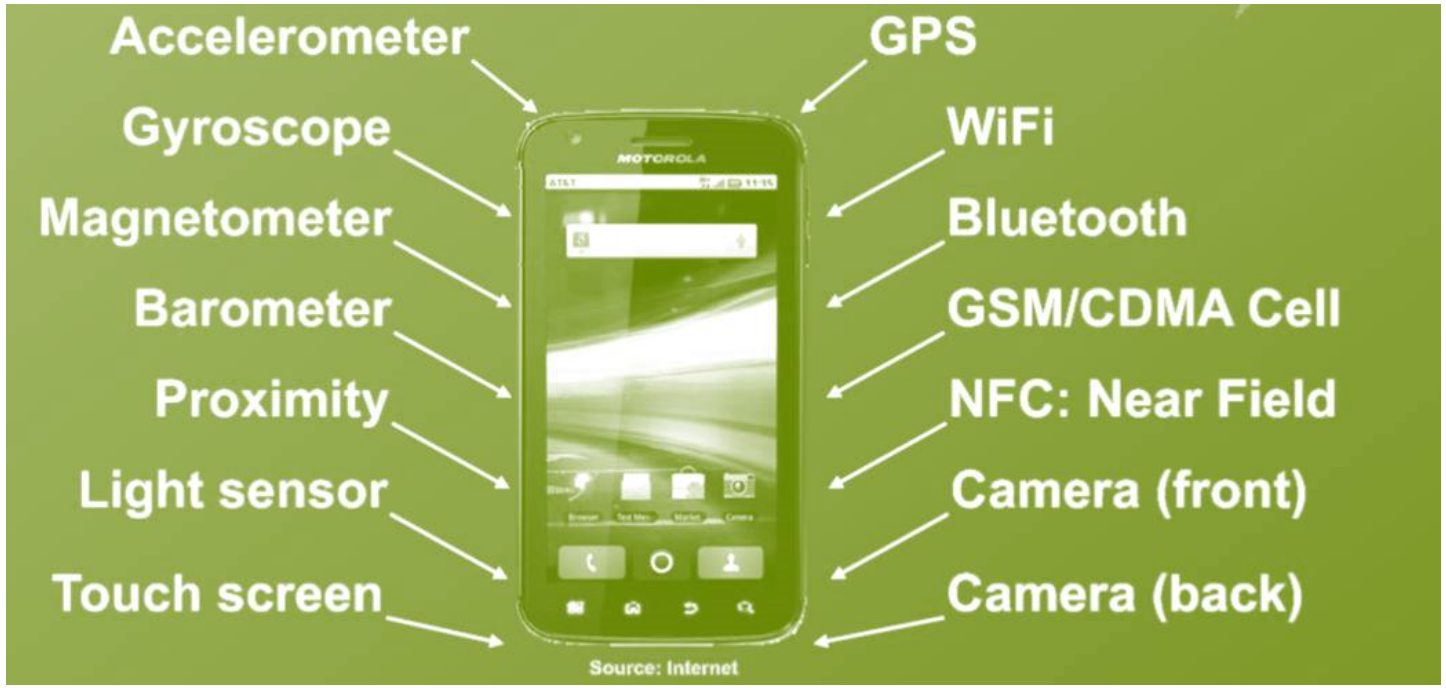
HOW DO YOU USE A SMARTPHONE ?



CAN WE USE SMARTPHONE FOR OUR HEALTH AND ACADEMIC PURPOSES?

Yes! We can. But we first have to learn how it works and performs different task.

A simple smartphone has several sensors for example:



AIM OF OUR EXPERIMENT

To…

- Learn how do the sensors respond on an oscillator and rotator.
- Analyze the data recorded by the sensors.
- To make graphs and phase portraits which explain the behavior.
- Know how they can be used in real life.
- To motivate you to use the smartphones for research, health sciences and industrial work.

OUR EXPERIMENT….

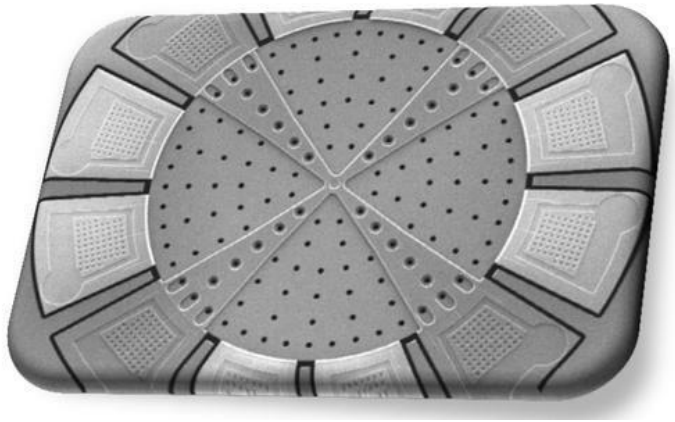
We ….

- Studied the motion of the bicycle wheel using the smartphone’s built-in accelerometer and gyroscope sensors.
- Explored the graphs of different physical quantities for example angular acceleration and angular velocity.
- Analysed phase-space trajectories of the motion.

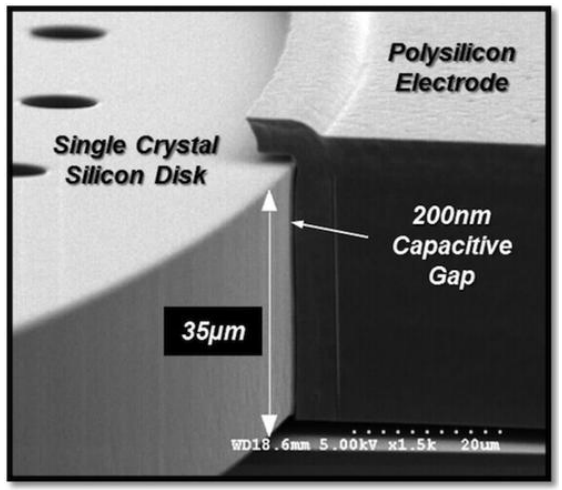
WHY TO OPT FOR WHEEL….

WHAT IS GYROSCOPE

Gyroscope is a sensor that can measure angular velocity around axis.



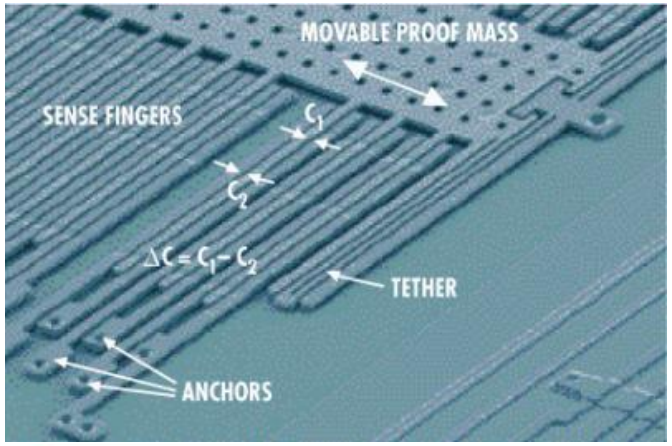
The single crystal silicon disk (centre) moves to track angular motion, which is sensed capacitively by the electrodes around the edge.



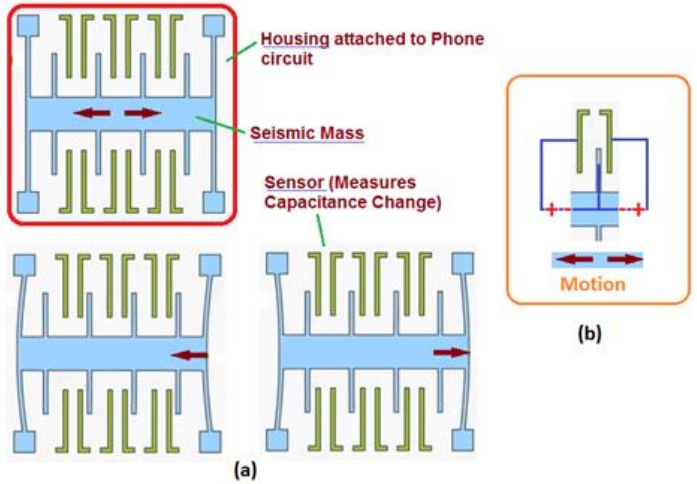
The tiny 200 nanometer gap between the central disk and the electrodes around the edge changes its capacitance as the disk rolls, yaws, and pitches.

WHAT IS ACCELEROMETER

Accelerometer detects a change in velocity in a given direction.

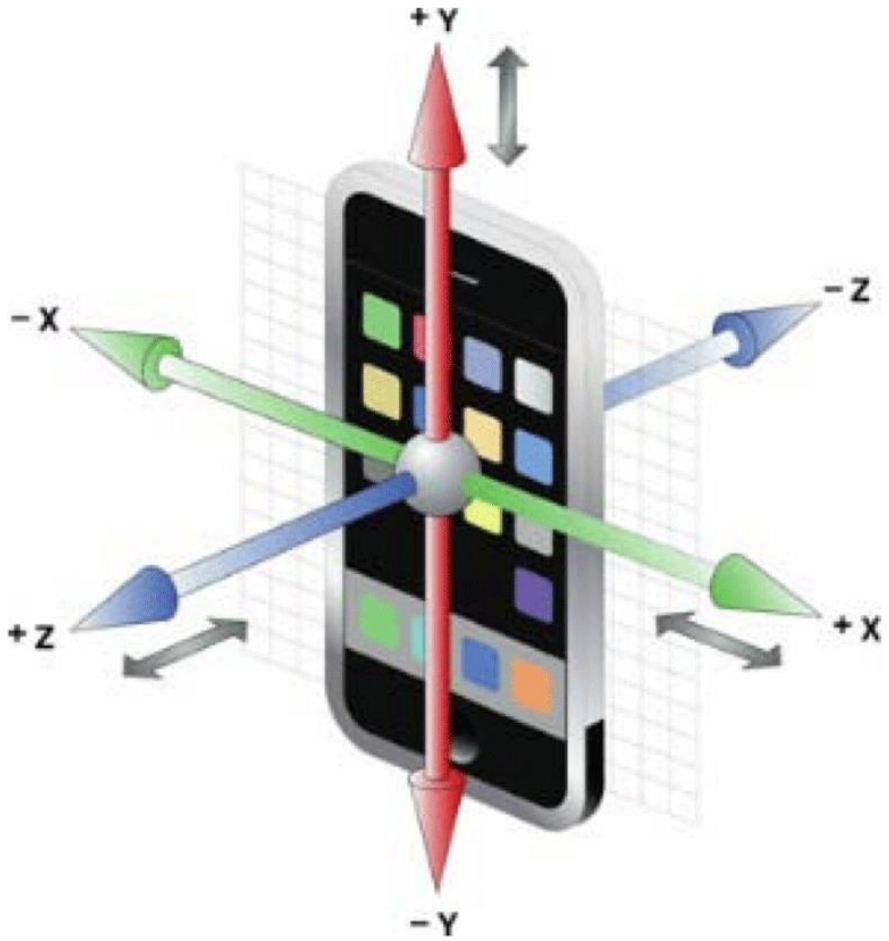


It consists of extremely tiny silicon springs—barely 1/50th of an inch in size—that move in accordance with gravity when you move your device.



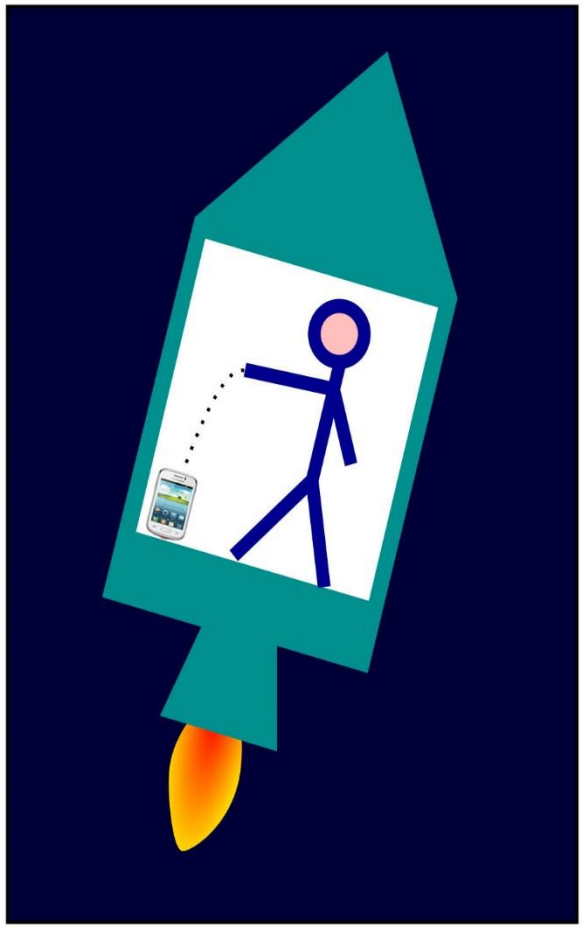
As the device moves, those microscopic springs create a small charge which can be measured and used to determine how your device is being accelerated.

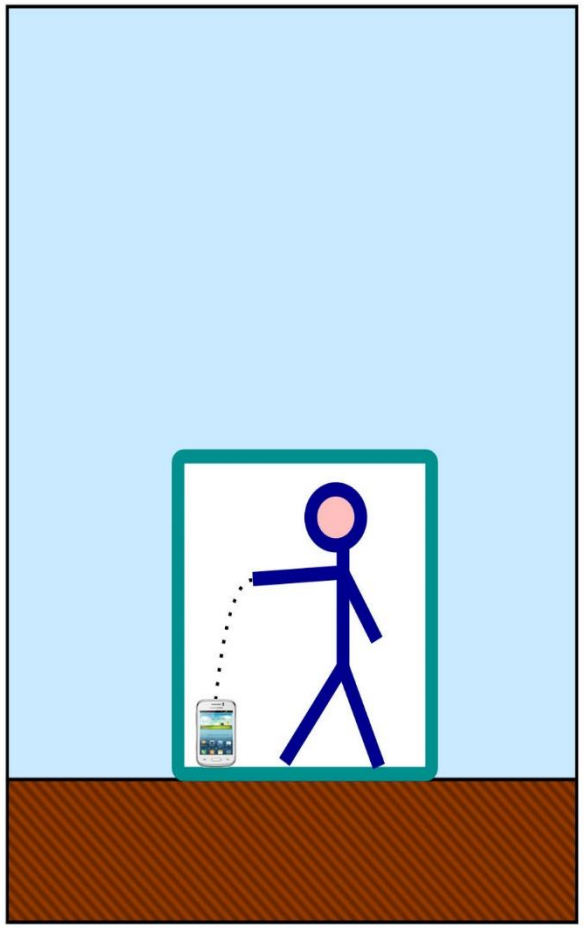
AXIS OF GYROSCOPE AND ACCELEROMETER



EQUIVALENCE PRINCIPLE

The equivalence principle is Albert Einstein's observation that the gravitational "force" as experienced locally while standing on a massive body (such as the Earth) is actually the same as the pseudo-force experienced by an observer in a non-inertial (accelerated) frame of reference.



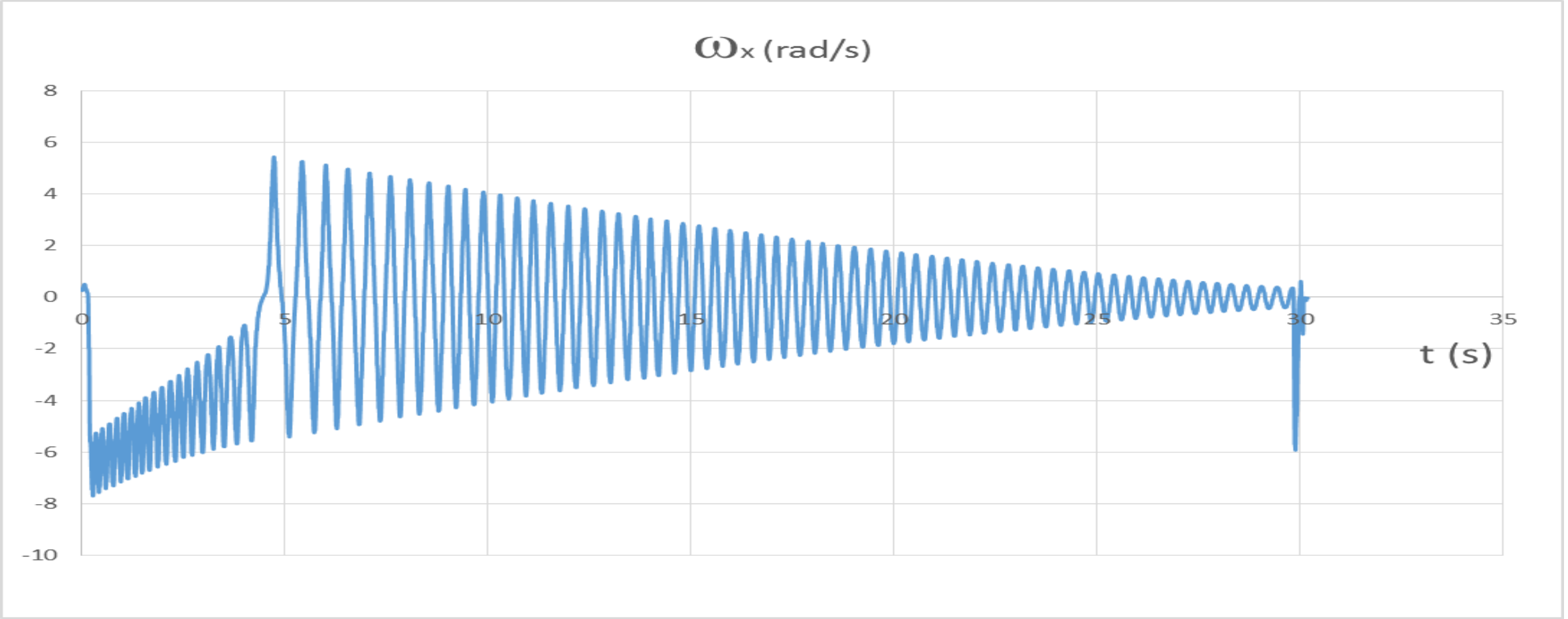


RESCALING OF AXIS

- The applications record the data in multiples of 9.8, so we have to convert it to actual observed values.
- Seems a very easy task ?
- Well, we had to convert about 11,000 X 6 values for a single experiment.
- And we repeated the experiment about 15 times.

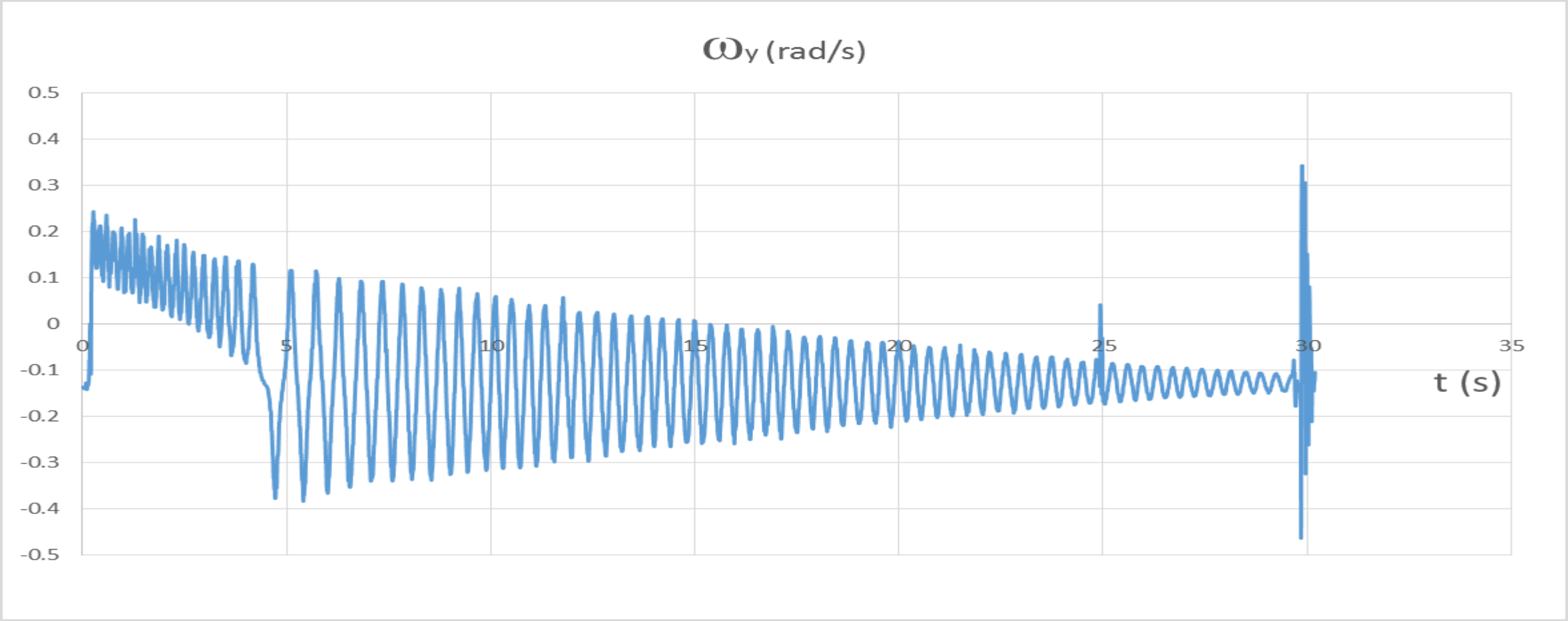
DATA ANALYSIS

Angular velocity of the wheel:
Along x-axis:



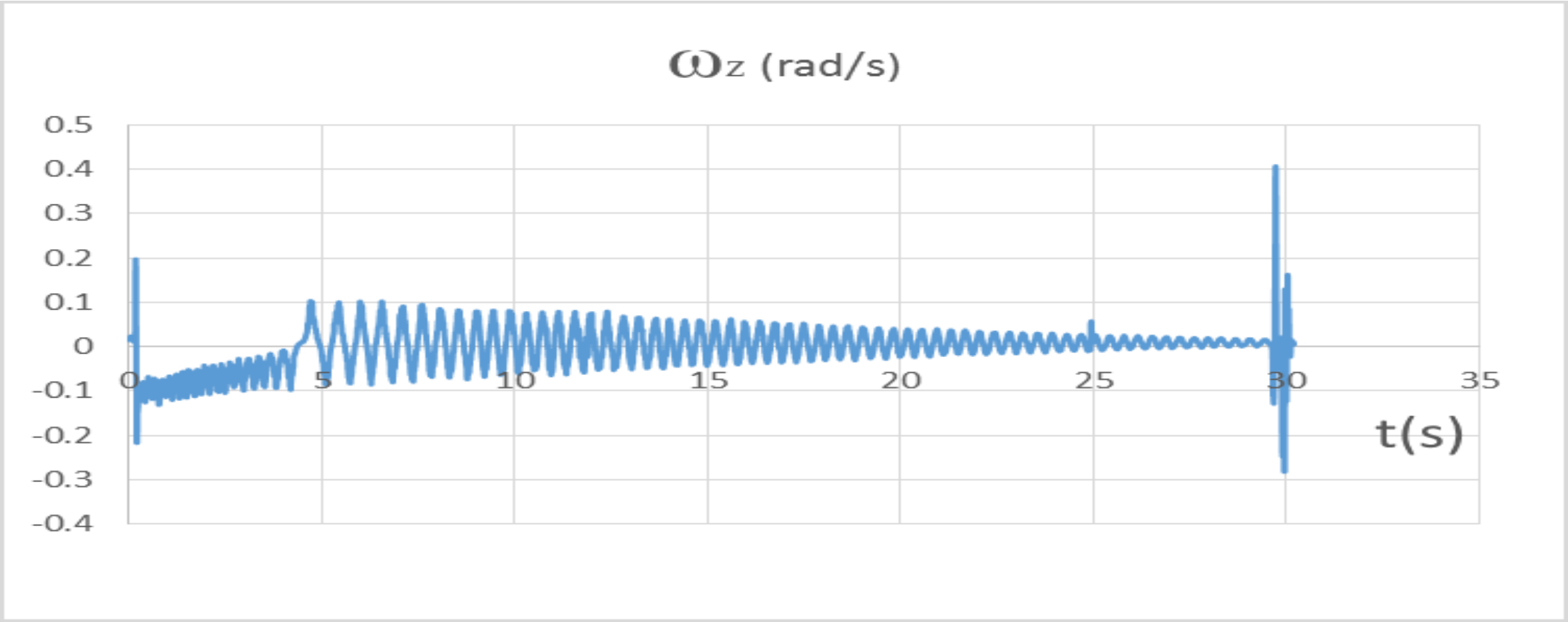
DATA ANALYSIS

Angular velocity of the wheel:
Along y-axis:



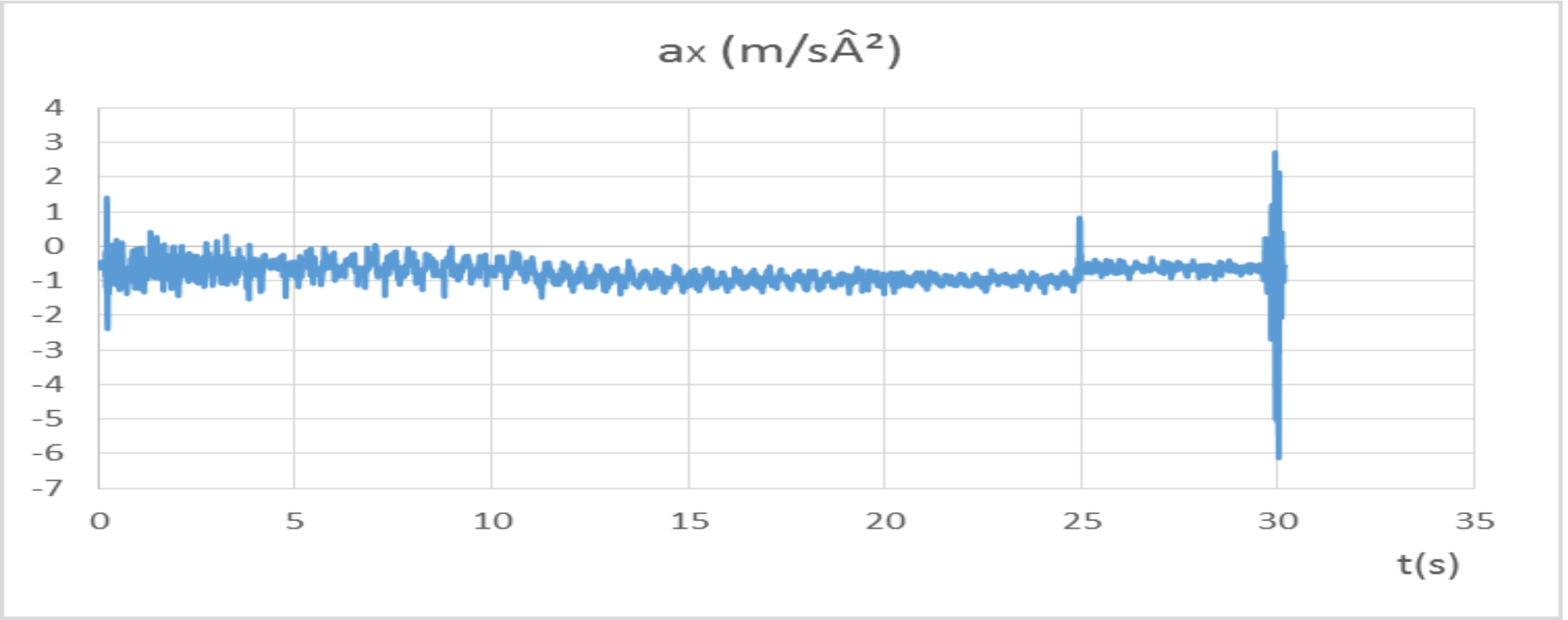
DATA ANALYSIS

Angular velocity of the wheel:
Along z-axis:



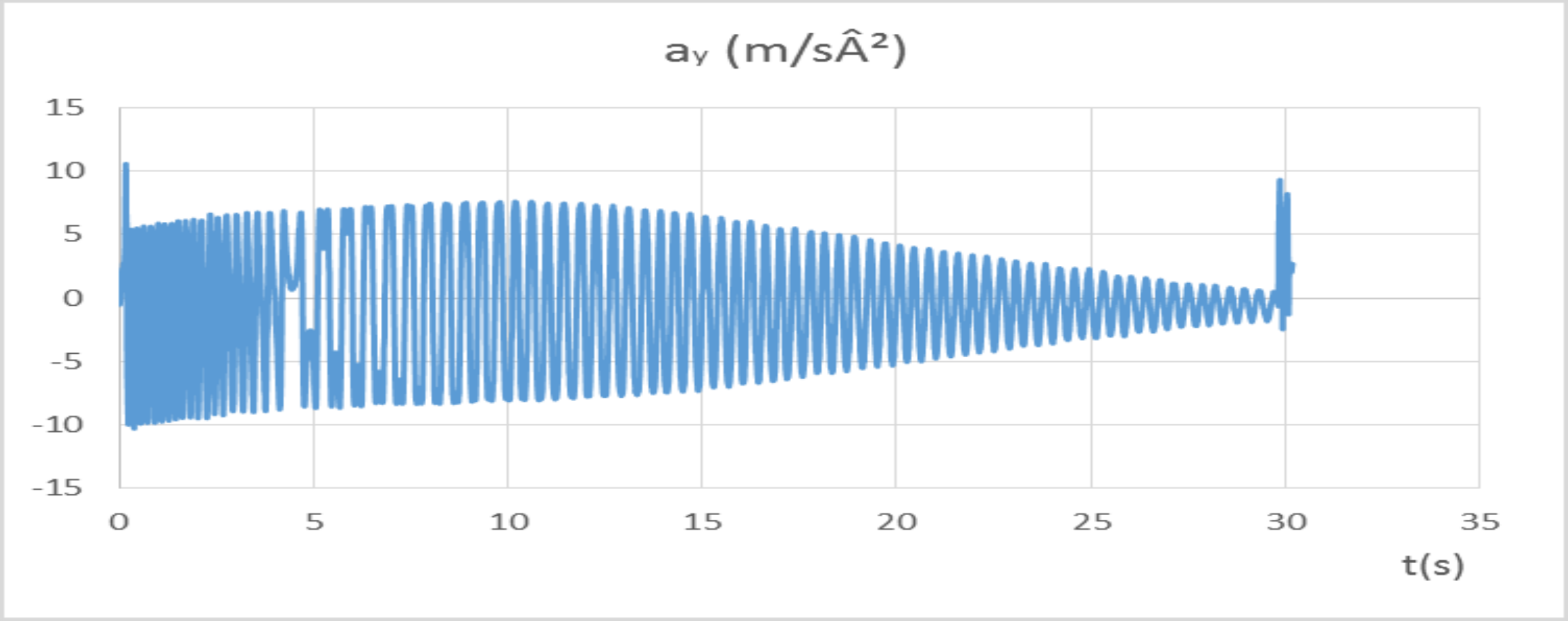
DATA ANALYSIS

Acceleration of the wheel:
Along x-axis:



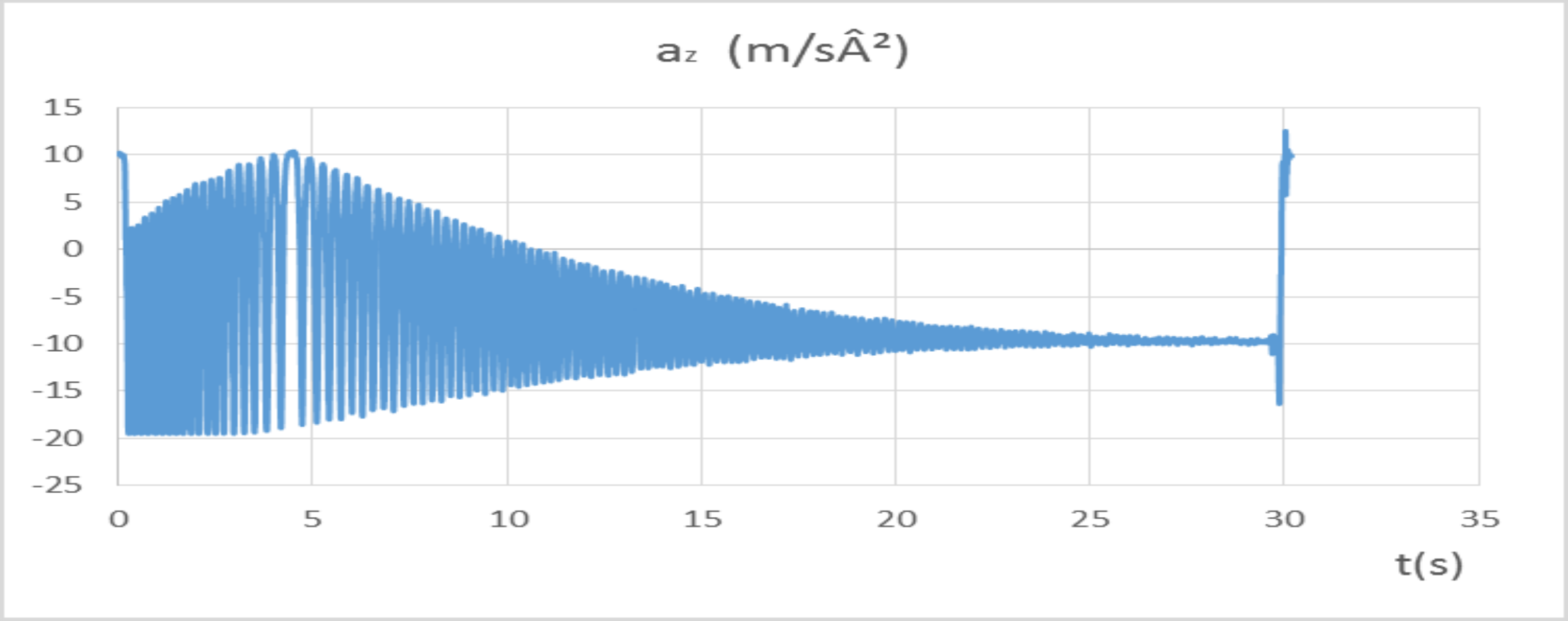
DATA ANALYSIS

Acceleration of the wheel:
Along y-axis:



DATA ANALYSIS

Acceleration of the wheel:
Along z-axis:

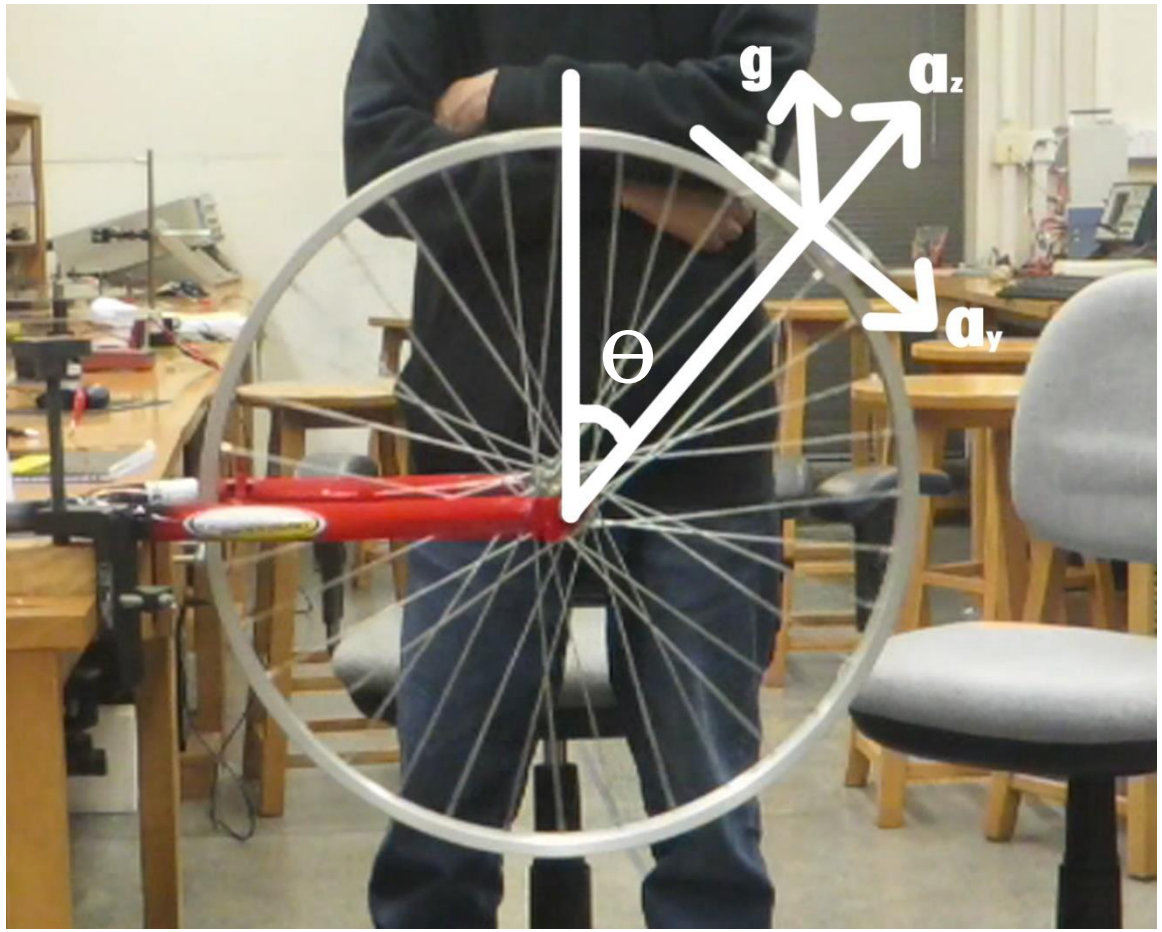


MATHEMATICAL ANALYSIS FORMULAS……

Actual acceleration

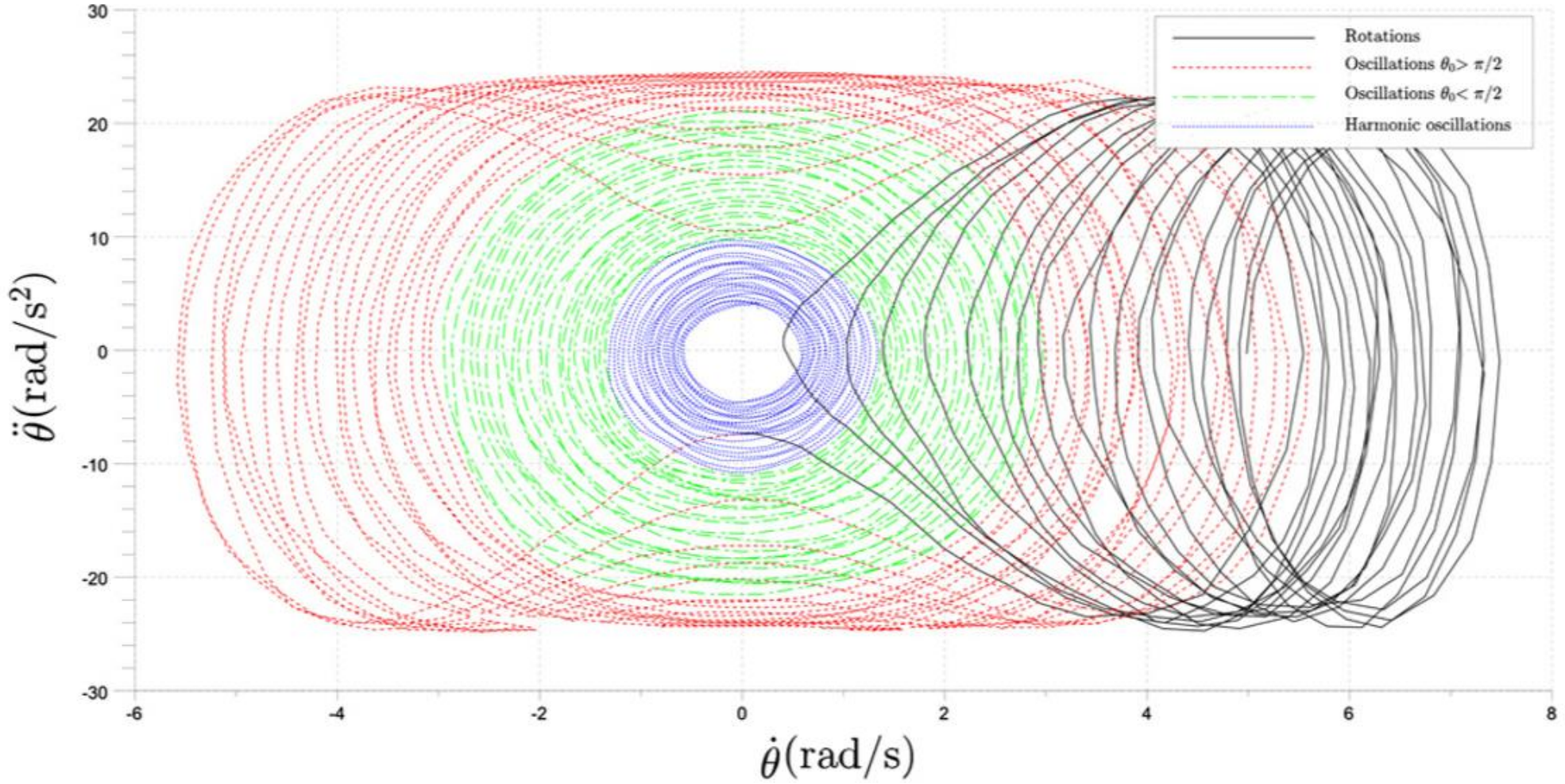
- a_x = 0 + acceleration due to wobbling of wheel
- $a_y = a_{observed} - g \sin(w_x t)$
- $a_z = a_{observed} - g \cos(w_x t)$

- Tangential acceleration = a_y
- Centripetal acceleration = a_z



PHASE PORTRAIT

EXPECTED



SOME OTHER PHYSICS EXPERIMENTS THAT CAN BE PERFORMED WITH SMARTPHONES

- Act like a microscope
- Analyze/view infrared light
- Pendulum
- Magnetic field detection
- Gravitation field with altitude and orientation
- Analyze the atmospheric pressure with altitude and orientation
- Sound analysis
- Electromagnetic field and current
- Spectrophotometer
- Light’s intensity detector
- And many more

WHAT ARE THE APPLICATIONS IN REAL LIFE

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HOW MUCH ACCELERATION MY KICK CAN PRODUCE ?


App Store
iTunes
Music
Reminders
ANY QUESTION(S)
Maps
Reeder
iMore
Instagram
Faves
Phone
Messages
Mail
Safari