Dust particle in DC glow discharge in ExB field

Abdirakhmanov A.R., Ramazanov T.S

IETP, Al-Farabi Kazakh National University

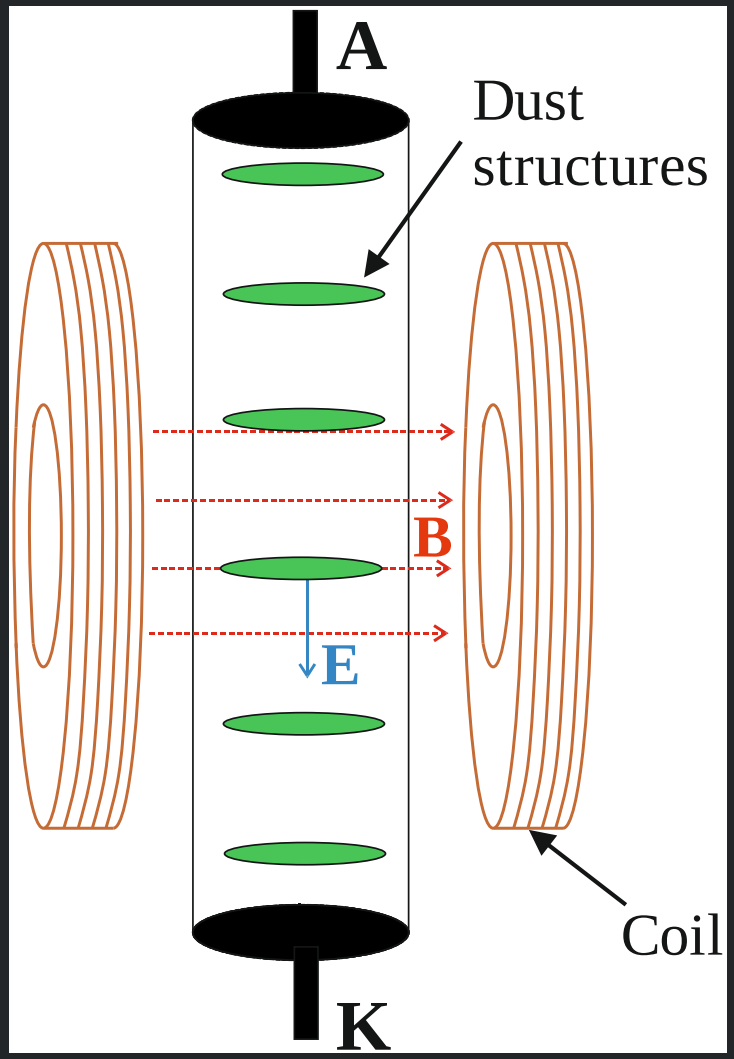
ExB Plasmas Workshop 2022

Madrid, online event

Contents

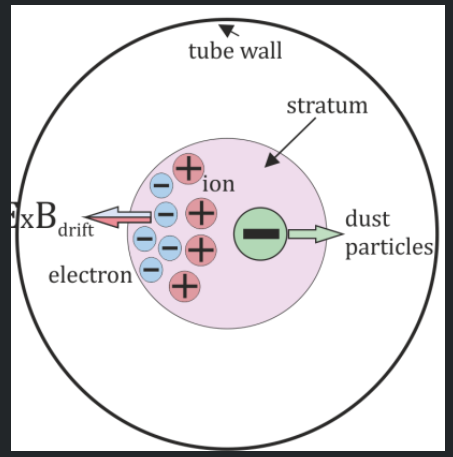
- Experimental Setup
- Results of experiment
- Conclusions

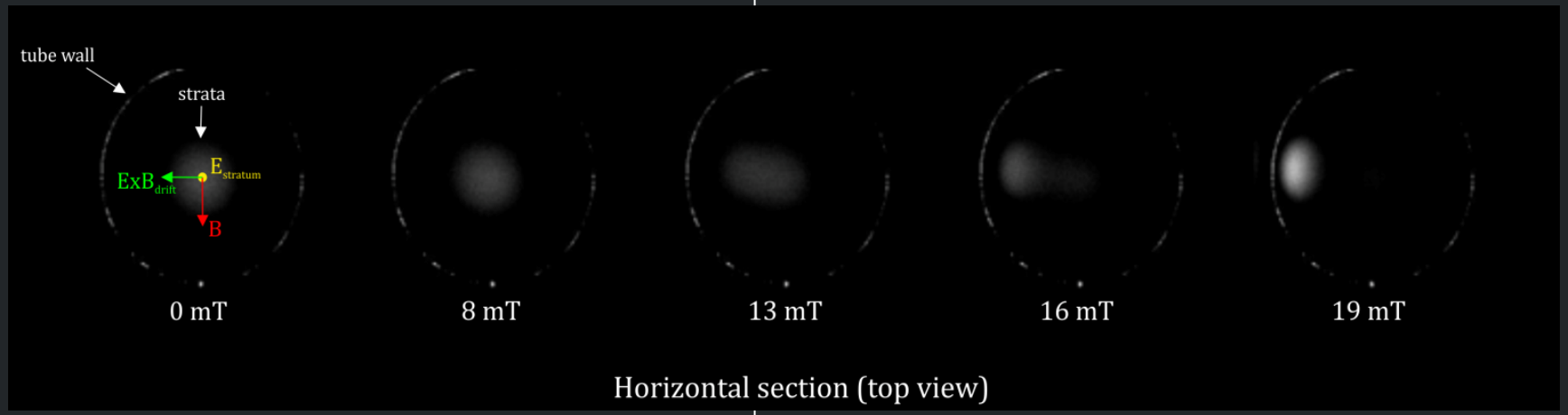
Experimental Setup

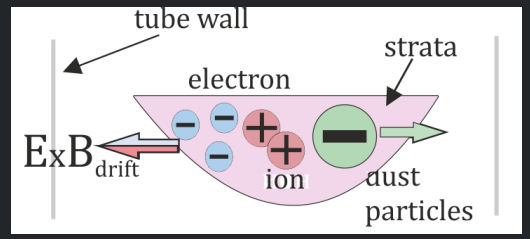


Parameter of experiment:
Gas: Ar
P=0.36 tor
I=1.44, 2.22 мА
B= 0-19 мТ

Illustration of glow discharge in ExB fields (Experimental results)







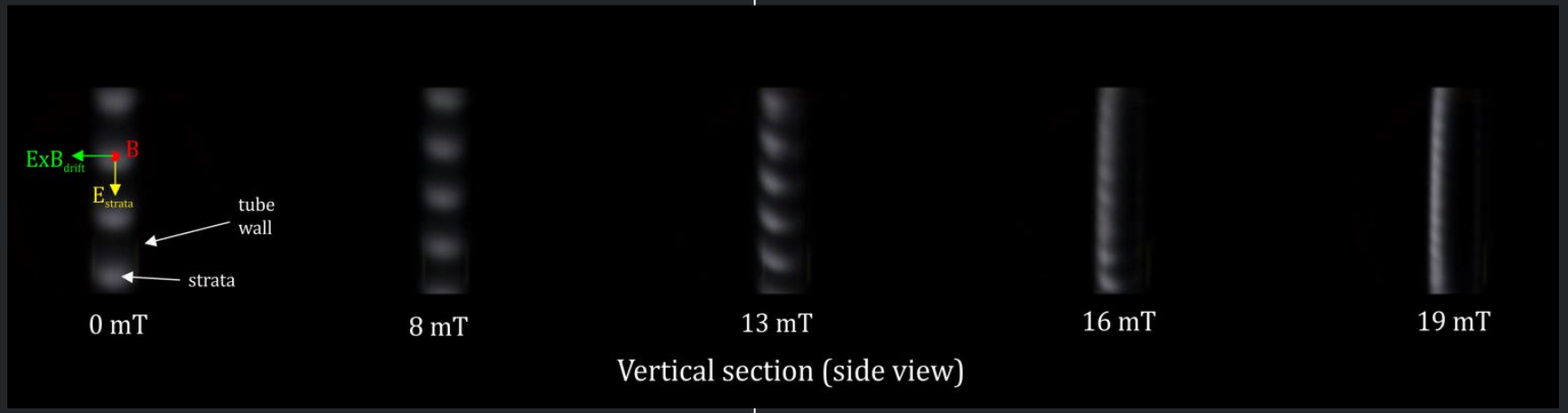


Figure 1. Horizontal and vertical DC glow discharge images at different magnetic field induction

Picture of dusty plasma in ExB fields (Experimental results)

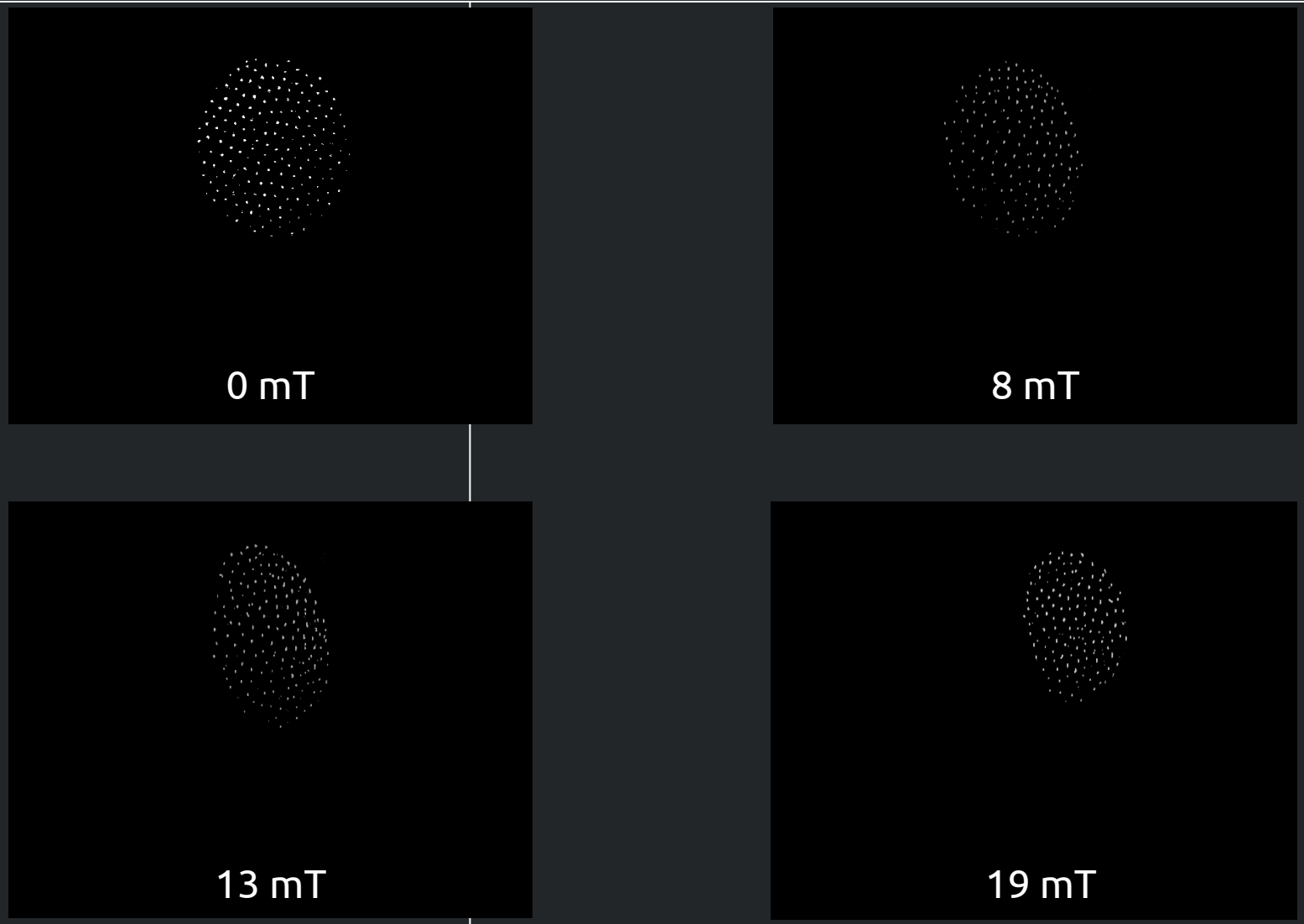


Figure 2. Emergence of vortex motion of dust structures

Picture of dusty plasma in ExB fields (Experimental results)

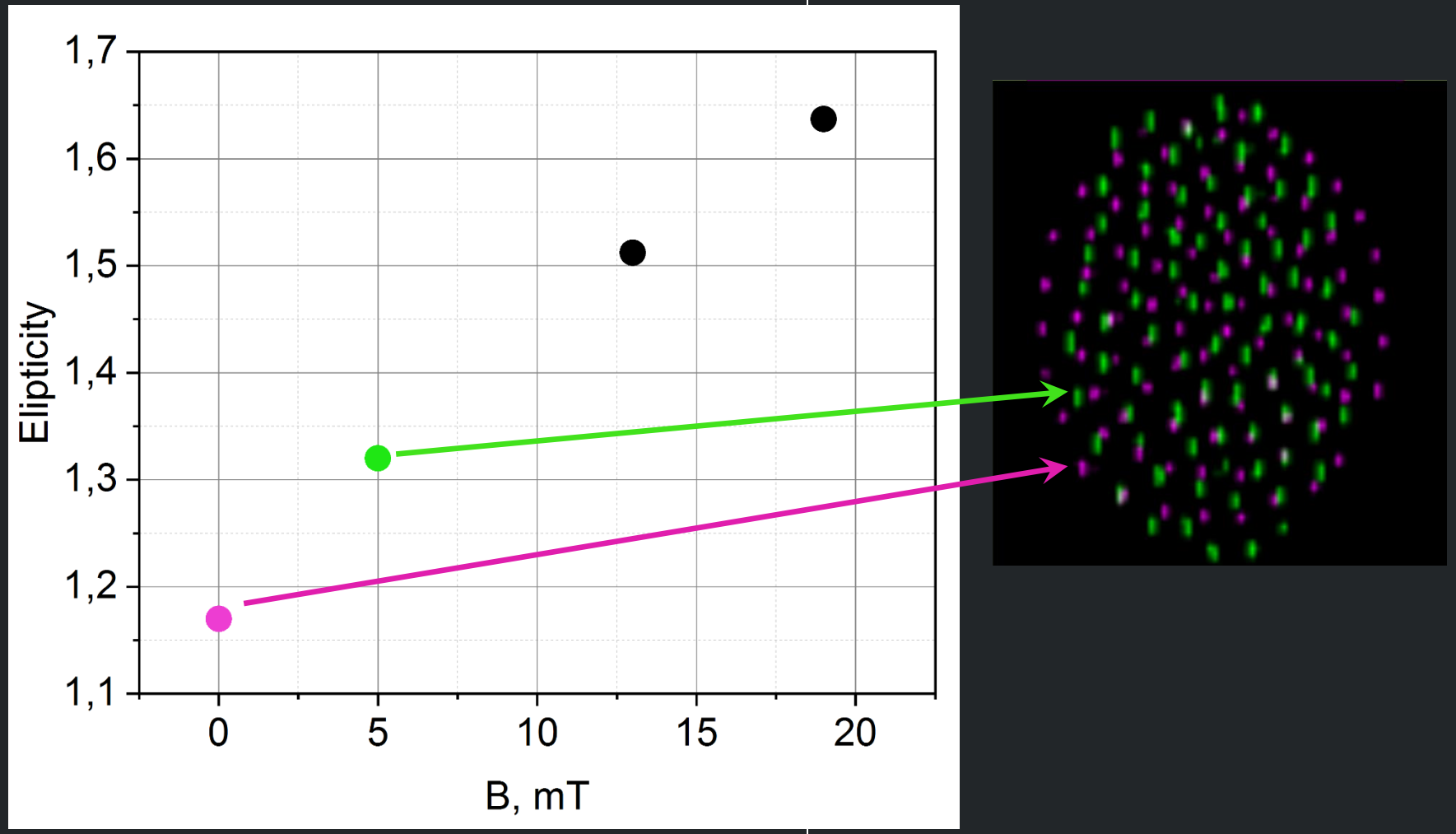
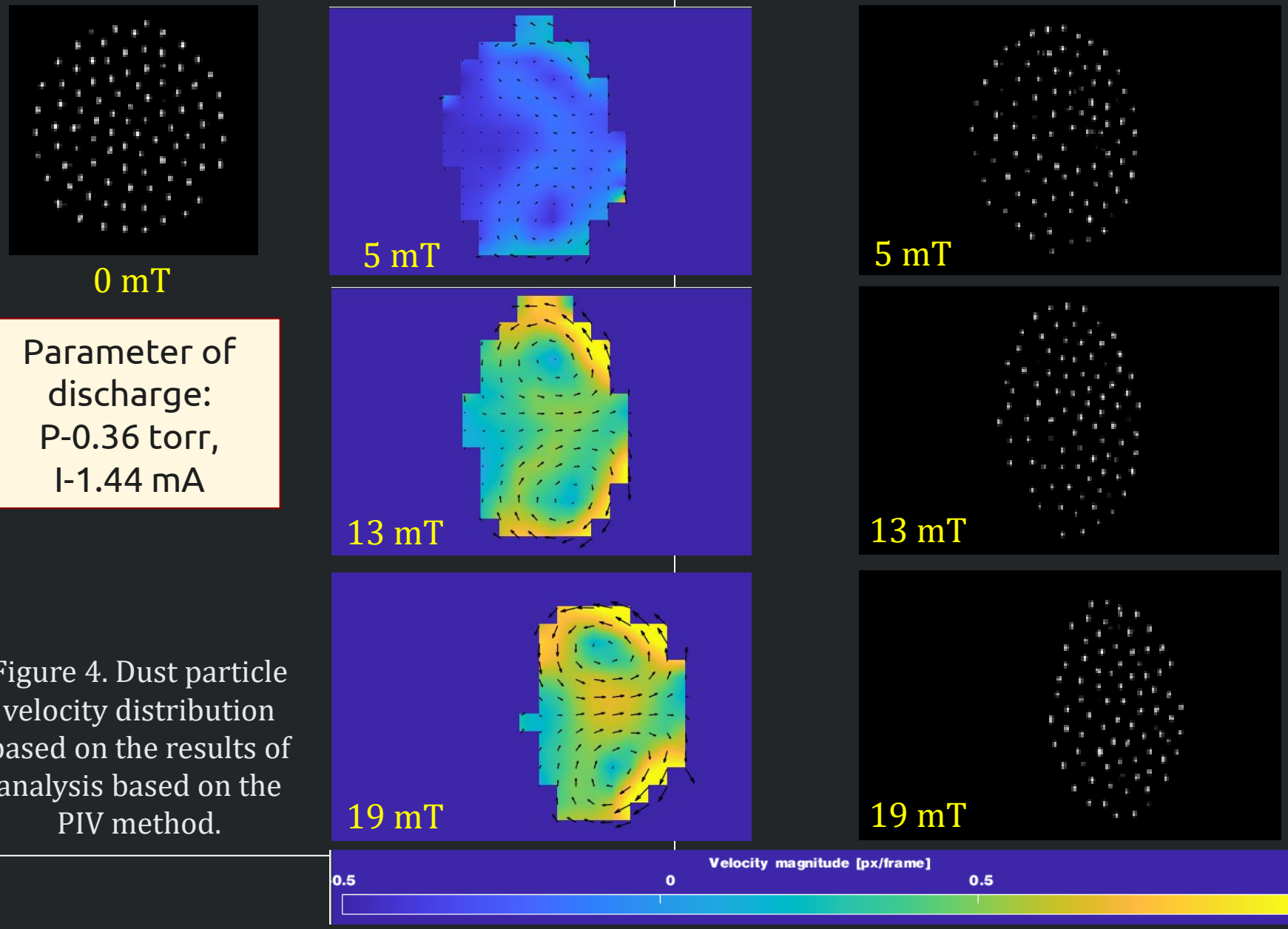


Figure 3. Dependence of ellipticity of dust structures on magnetic field induction.

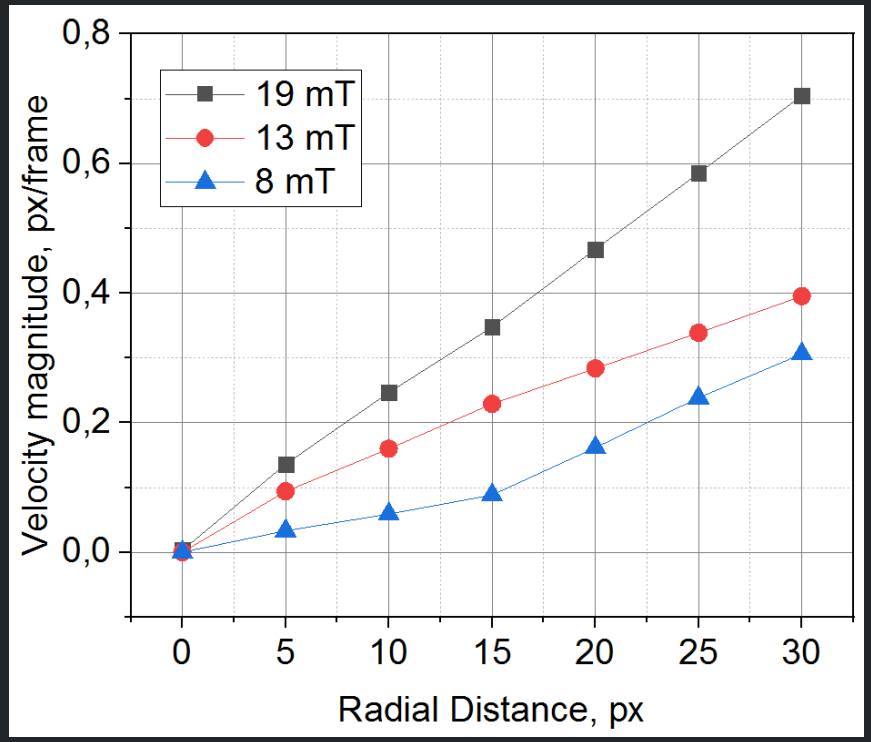
PIV Analysis of Results (Experimental Results)



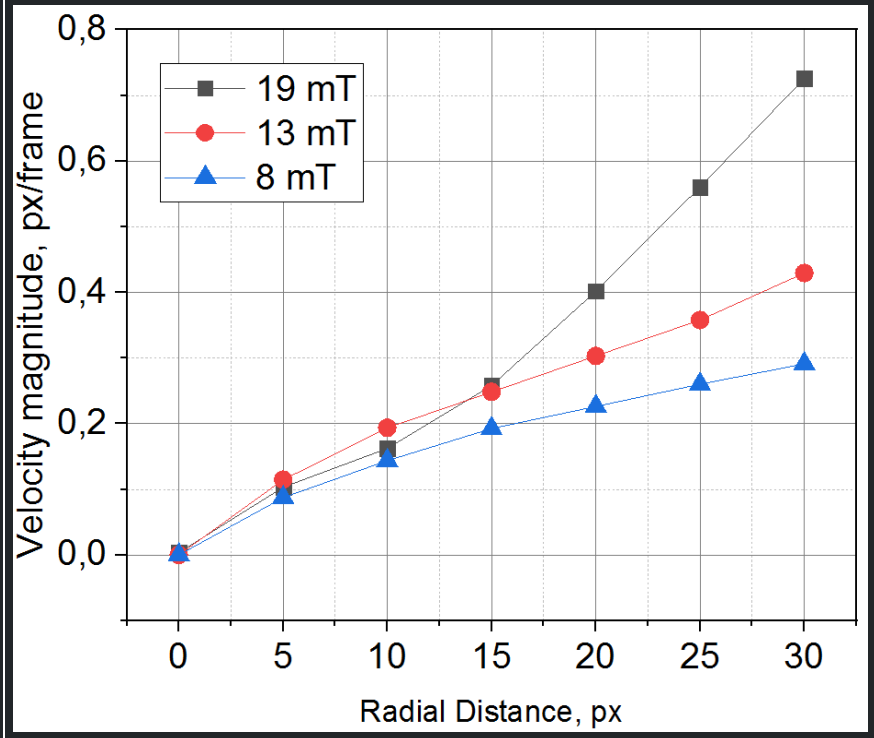
Parameter of discharge:
P-0.36 torr,
I-1.44 mA

Figure 4. Dust particle velocity distribution based on the results of analysis based on the PIV method.

PIV Analysis of Results (Experimental Results)



a) Vortex I (counterclockwise rotation)



b) Vortex II (clockwise rotation)

Figure 5. Dependence of linear velocities of dust particles in vortices on radial distance

Interpretation

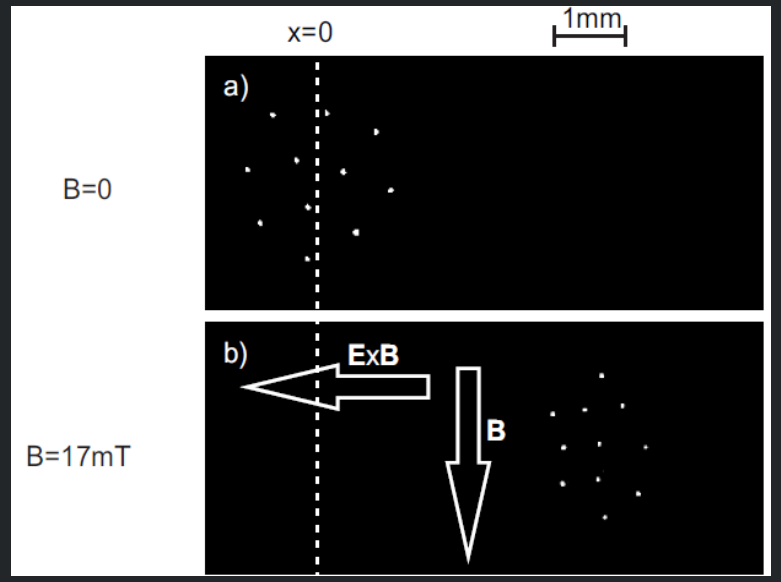


Figure 6.Top view camera images for an experiment at 4.5Pa.

M. Puttscher and A. Melzer. Dust particles under the influence of crossed electric and magnetic fields in the sheath of an rf discharge Physics of Plasmas 21, 123704 (2014)

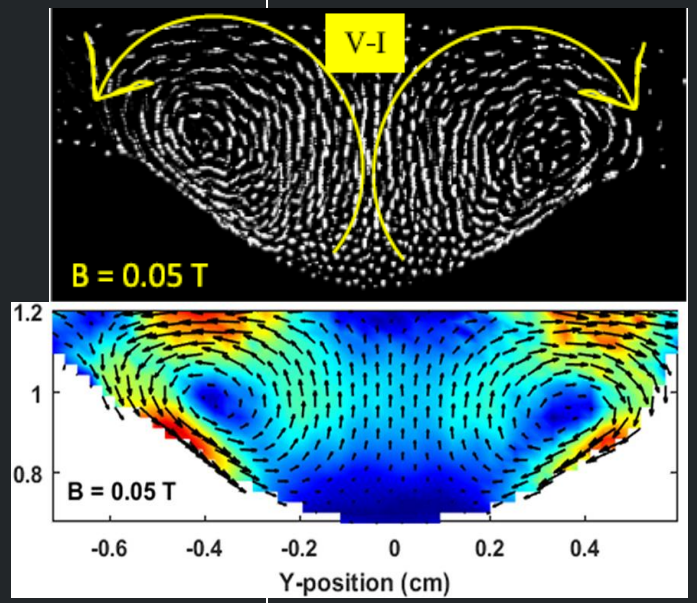


Figure 7. Video and PIV images of the dust cloud

M.Choudhary et.all. Three-dimensional dusty plasma in a strong magnetic field: Observation of rotating dust tori
Phys. Plasmas 27, 063701 (2020);

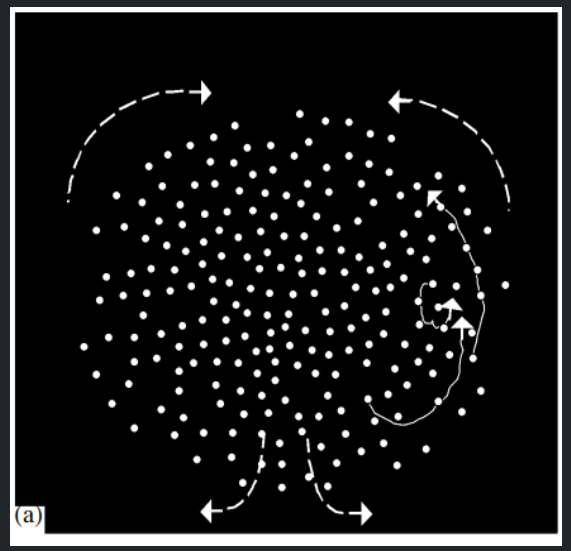


Figure 8. Schematic diagram of convection of macroparticles in the stratum of a glow discharge

Vaulina, O. S., et.all. Self-excited motions in dusty plasmas with gradient of charge of macroparticles New Journal of Physics, 5 (2003)

Conclusions from the experiment

- An oppositely rotating vortex in the horizontal plane is observed
- The angular frequency of particle rotation increases with increasing radial distance of particles from the center of the vortex (differential rotation vortex).
- As the external magnetic field increases, the angular frequency of rotation increases.
- The volume of the dusty plasma decreases as the magnetic field increases

Acknowledgments

This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP08855651).