

# «THE EFFECT OF TERAHERTZ EMR ON CYCLOSIS AND THE RATE OF MOVEMENT OF CHLOROPLASTS IN ELODEA LEAF CELLS»

U.A. Belyachenko, A. P. Rytik, O. U. Kutikova, A.O. Timofeeva

Saratov State University  
83 Astrakhanskaya Street, Saratov, 410012

## Abstract

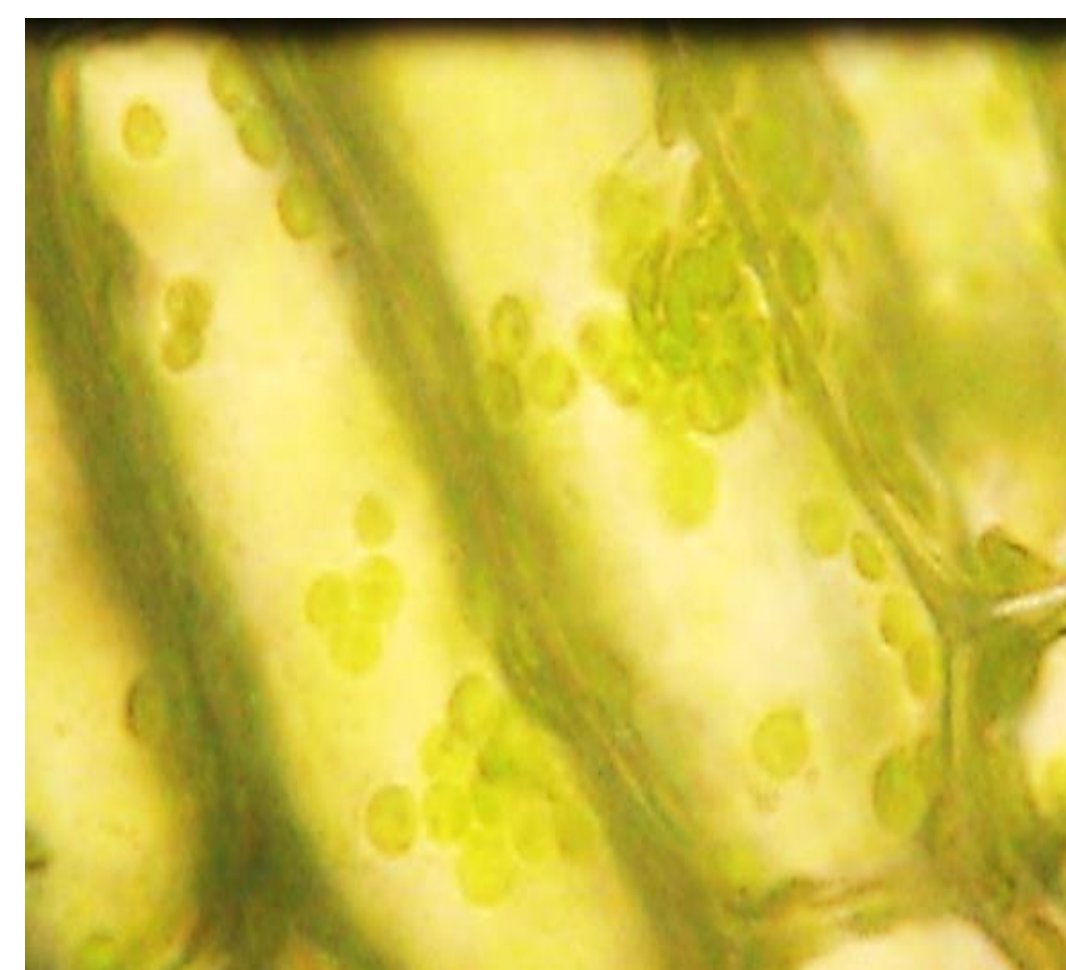
The paper presents the results of a study of the effect of EMR on the intensity of cyclosis and the speed of movement of chloroplasts in the cells of the elodea leaf.

**Keywords:** cyclosis, visualization of microwave radiation, EHF radiation, elodea, electromagnetic radiation.

## Introduction

It is generally recognized that electromagnetic radiation affects almost all levels of functioning of any species – from the simplest to humans. Fundamental studies of the influence of the microwave range will allow us to apply the knowledge gained for targeted effects on living organisms.

The test object in this study was the Canadian elodea (*Elodea canadensis* Michx.), an aquatic plant of the Vodokrasaceae family. This object is convenient for studying the movement of the cytoplasm (cyclosis) and the movement of chloroplasts inside the cell.



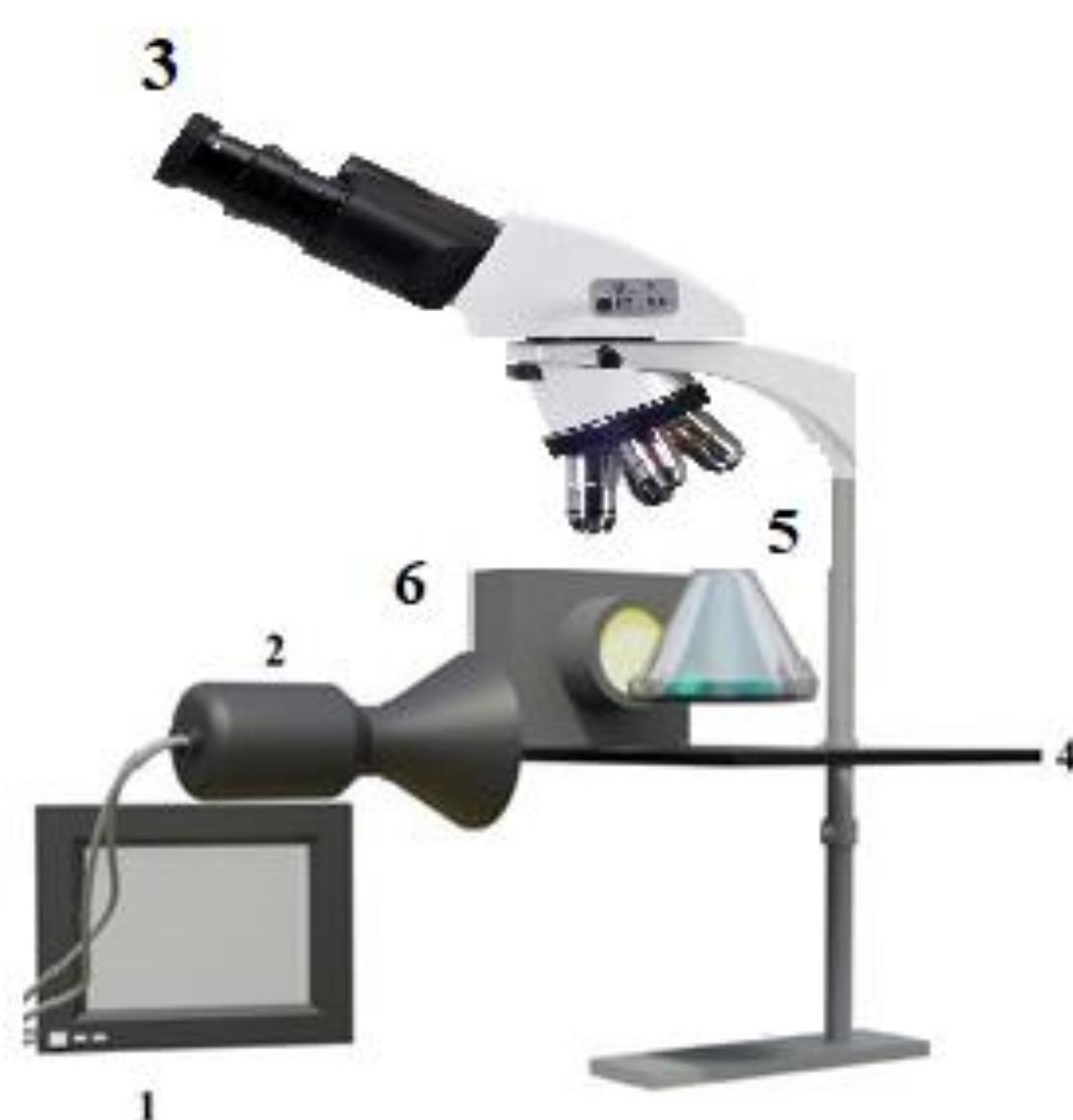
Since the small thickness of the sheet and the optical transparency of the cell layer are convenient for microscopic examination of living cells.

## The purpose of this research

The aim of the study is to study the effect of microwave EMR on the intensity of cyclosis and the speed of movement of chloroplasts in the cells of the elodea leaf to visualize the effect of electromagnetic radiation.

## Materials and methods

### Experimental setup



- 1 - PC;
- 2 –video camera ;
- 3 – microscope;
- 4 – Subject table;
- 5 – test object;
- 6 – generator;

To carry out the research, an experimental installation based on the G4-142 microwave signal generator and the EHF-1 generator was developed. Elodea leaves from the upper part of the shoot were used as the studied medium. The electromagnetic radiation imaging device consists of: a generator operating in the microwave and HF bands, a slide with a sample of the study, a microscope, a video camera and a computer.

## Results and Discussion

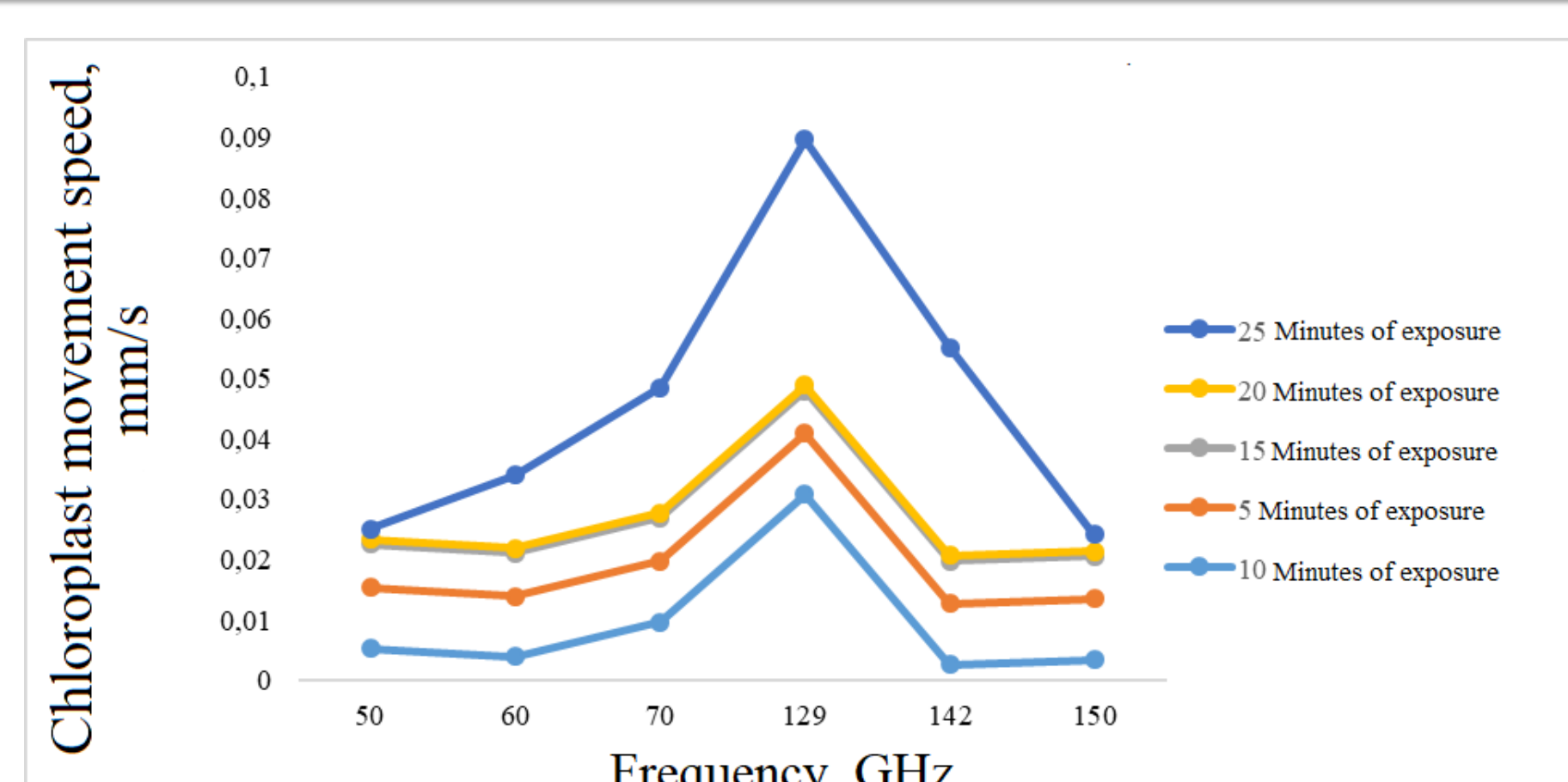


Fig. 1. The dependence of the speed of movement of chloroplasts on the frequency of exposure to EMR of different duration

Table 1 – The rate of movement of chloroplasts in the cells of the elodea leaf

Frequency of exposure, GHz	Speed, mm/s				
	1	2	3	4	5
0	0,0020	0,0015	0,0021	0,0020	0,0030
60	0,0030	0,0030	0,0035	0,0040	0,0041
150	0,0800	0,0800	0,0760	0,0800	0,0840

When exposed to EMR with a frequency of 60 GHz, the speed of movement of chloroplasts, on average, increased by 1.7 times (by 66% relative to the control), when exposed to a frequency of 150 GHz – by 37.7 times. According to the analysis of variance, the differences between the control parameters and the values of the chloroplast movement velocity in the experiment at a frequency of 60 GHz are significant at  $p = 0.003$ . The differences between the control and the exposure option at 150 GHz, as well as between different experimental options, are significant at  $p < 0.001$ . Statistical data processing using the nonparametric Mann-Whitney criterion confirms the differences between the control and exposure options of 60 GHz ( $p = 0.016$ ) and 150 GHz ( $p = 0.009$ ), as well as between different experimental options ( $p = 0.016$ ).

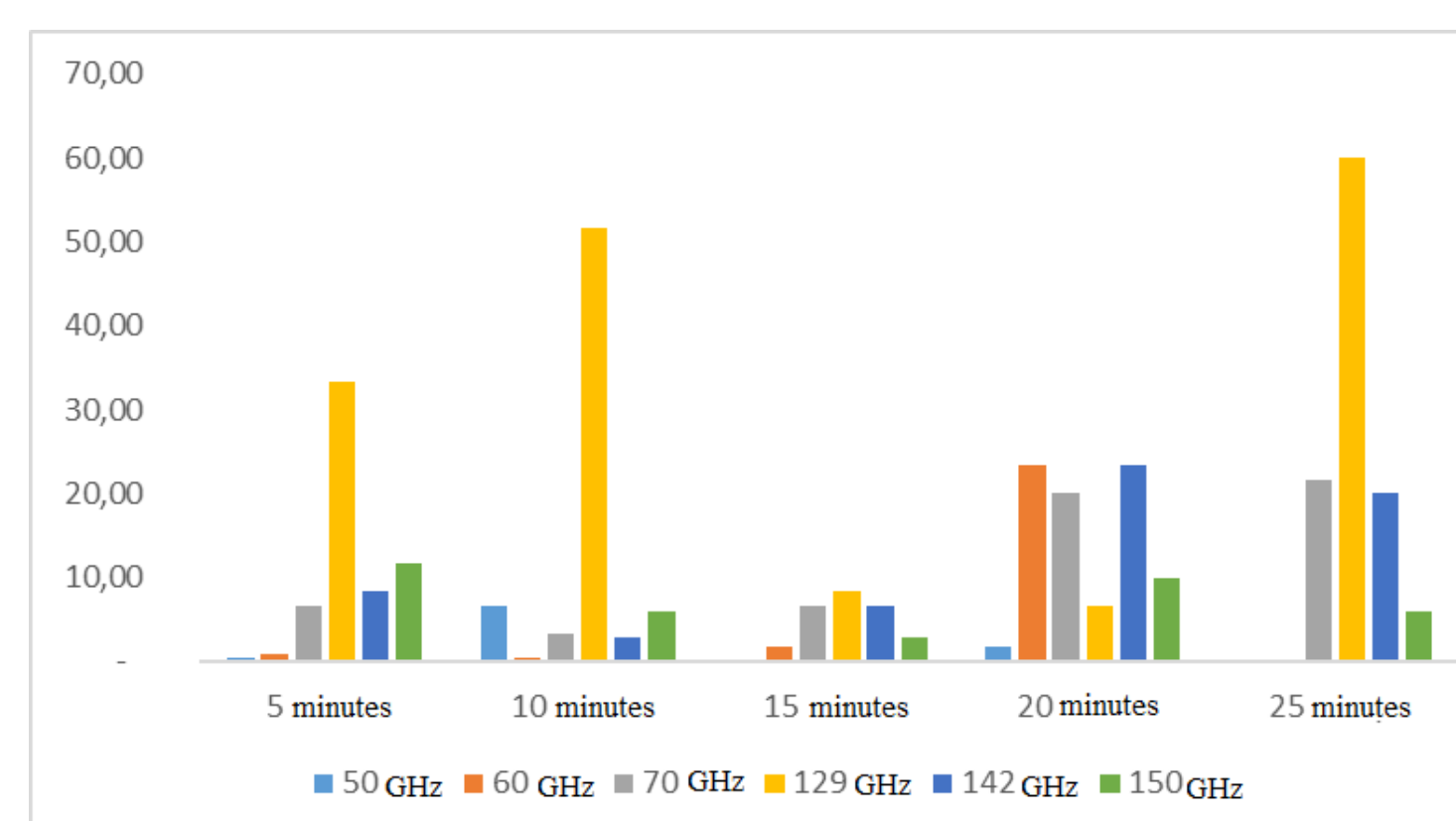
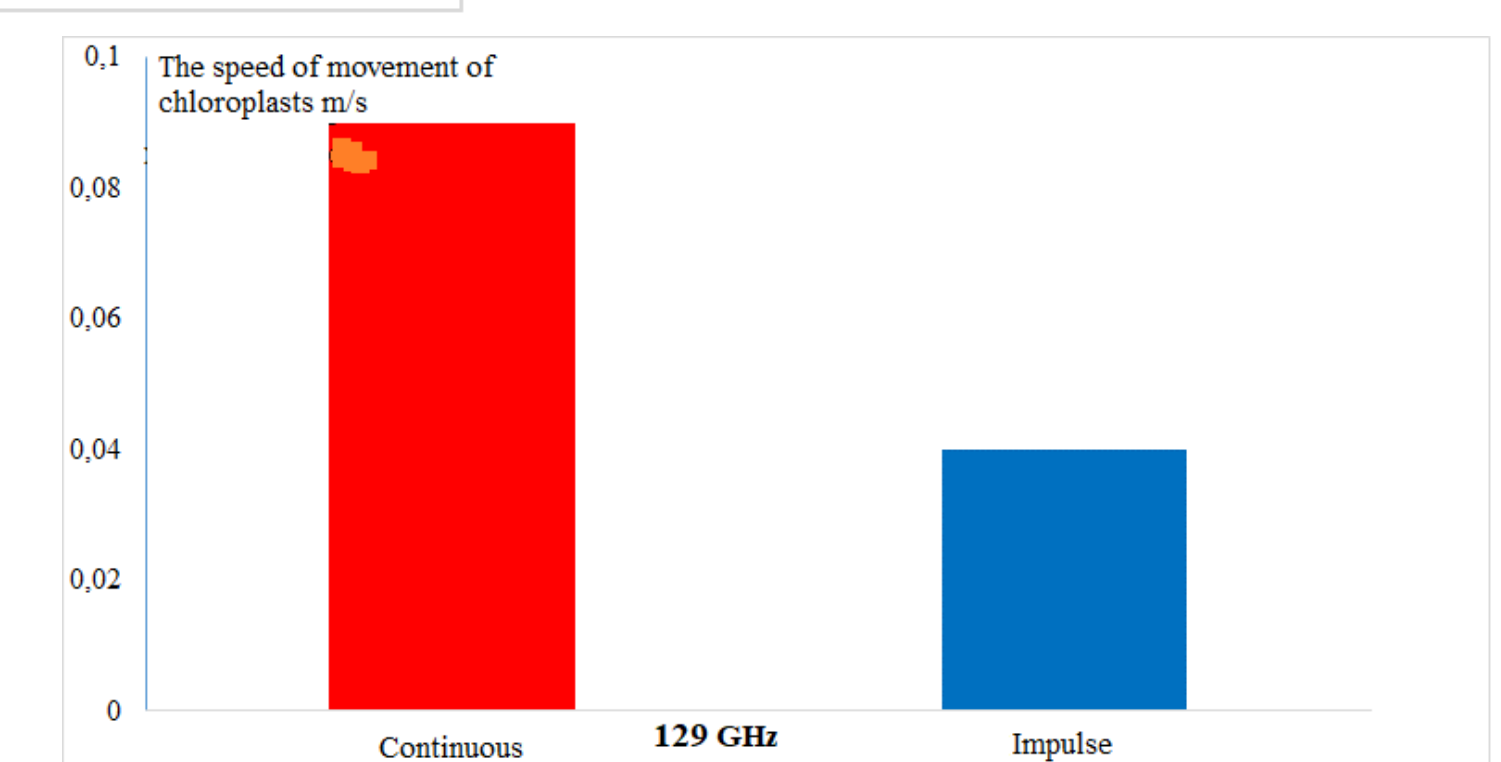


Fig. 2 Dependence of the average speed of movement of chloroplasts on the frequency of the affected EMR

Fig. 3 the rate of chloroplasts at a frequency of 129 GHz in a continuous and pulsed cycle



## Conclusions

The effect of millimeter waves on biological objects indicates the possibility of the existence of mechanisms of interaction of EHF waves with cells of plant origin, which affect the fundamental aspects of their vital activity and the functioning of cell membranes. Since the number of devices and devices generating various kinds of radiation is increasing every year, it is relevant to study their impact on living objects. The detection of the effect of EMR on the speed of movement of chloroplasts of cells inside elodea cells determines the relevance of conducting such studies for scientific and practical purposes.

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