

## Using Raidation2D

Tsumoru Shintake 2008

Shintake@oist.jp

### 1. **About 2008 Version**

After starting delivering original version of Radiation2D.exe, it has been 10 years past. There were about 5000 downloads from whole over the world

This 2008 version is single executable file: Radiation2D.exe, which can be start up from Desktop or USB memory.

### 2. **Starting program.**

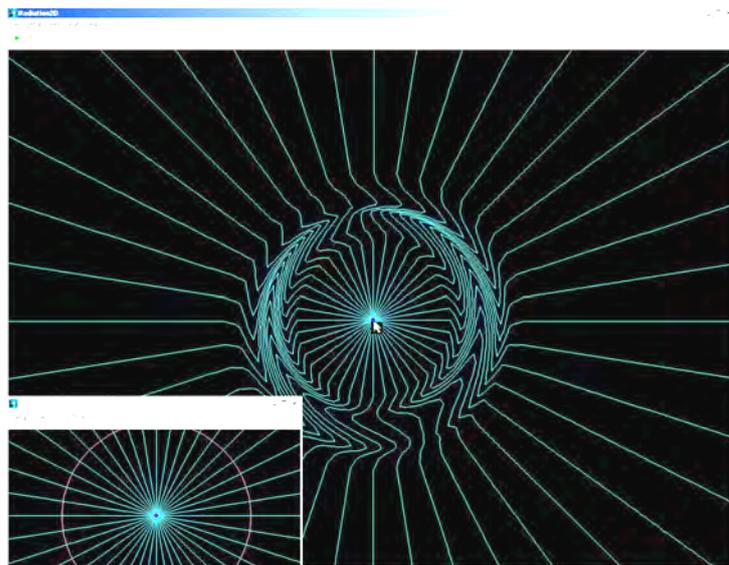
Copy or download program to desktop or your preferred folder. Double click icon, then it will start to run. In case if you use Mac, you need Windows emulation software, such as, Parallels.

Mac and iPad version will be ready soon.

### 3. **Initial condition is “Moving by Mouse”**

Bring your mouse pointer on to center circle (electron), press left button and drag to mover. Wave like motion starts to run along with blue lines (electric field lines), this is the radiation of electro-magnetic wave.

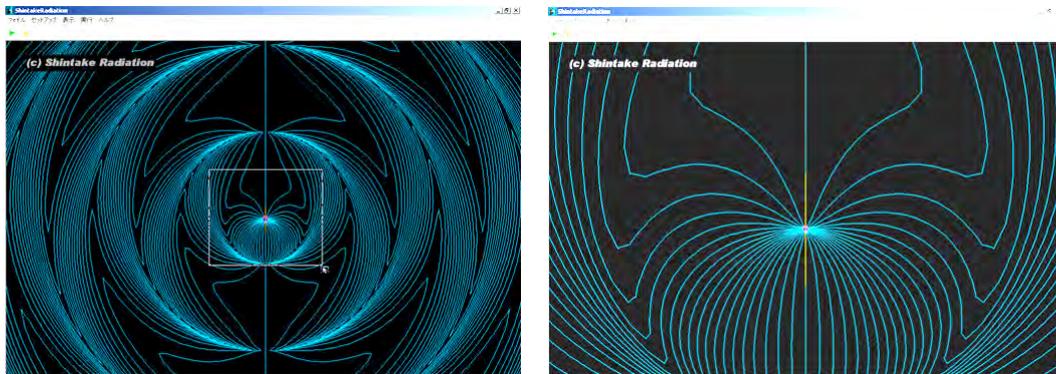
In reality, the speed of the wave is the speed of the light, which is very fast:  $c = 3 \times 10^8$  m/sec, thus your eye cannot catch. To show it on graphics, the speed of the light is made very slow:  $\sim 10$  cm/sec, or you may think time elapses very slowly.



By moving red circle (electron) at the center, using you mouse by pressing left button, the wave start to propagate outward, this is the electromagnetic wave.

#### 4. Controls View

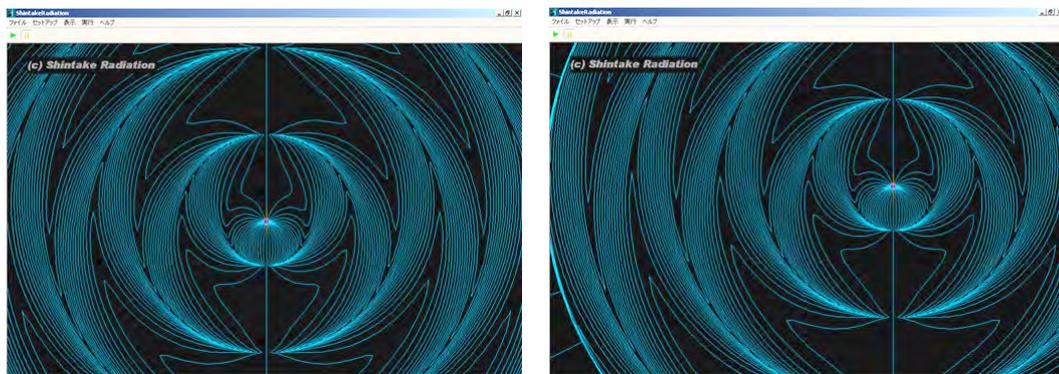
**Expanding:** Pressing left mouse button and drag. Selected area is expanded.



**Rset expand:** Press left mouse button, and drag to left-up direction, then expansion will be rest.

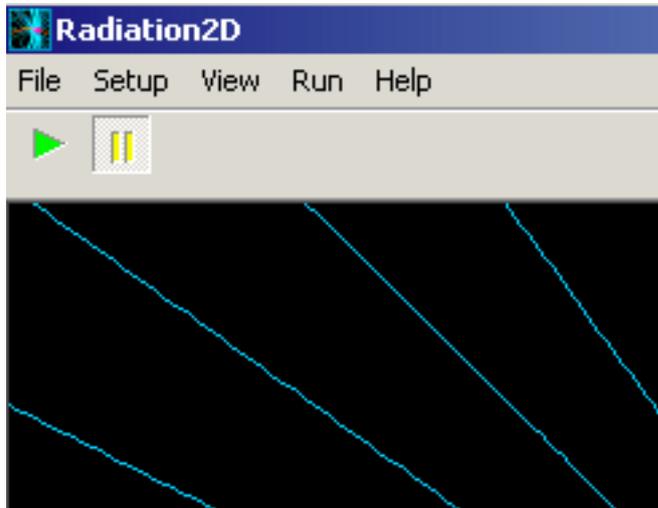


**Panning:** Press right mouse button, and drag to any direction.



## 5. Pause Motion

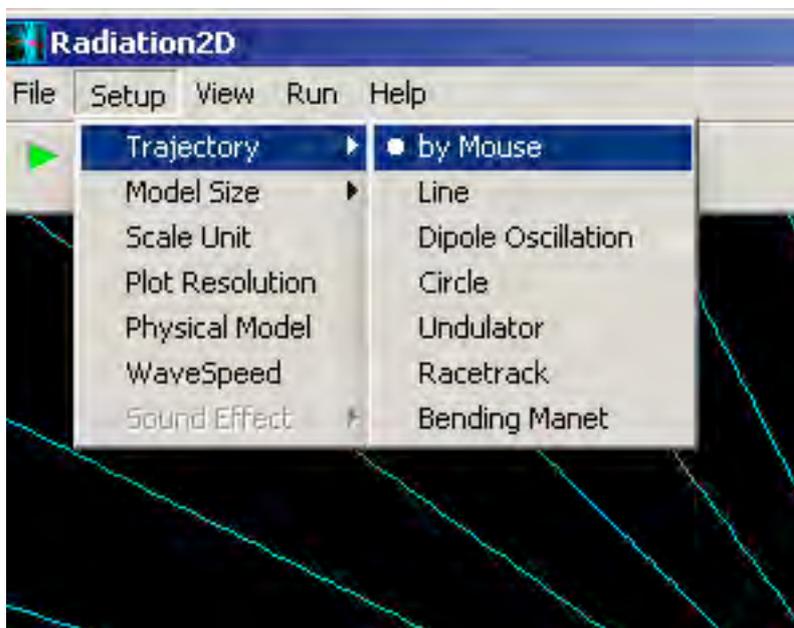
You may pause execution by press yellow pause button at left upper corner. Press button again, single simulation step will be executed. You may restart by pressing green arrow button.



When Ration2D runs, it uses fully 100% CPU resource. When you want to show Radiation2D during your presentation, it will be a good idea to pause execution when you show other presentation.

## 6. Selecting various kinds of radiations.

You can select kinds of radiations, i.e., preset automatic motion of electron, from the “Setup Trajectory” pull down menu.



From the top

**by Mouse:** using mouse, you may move electron in any directions. Maximum speed is limited below speed of light (speed of wave propagation).

**Line:** constant speed motion along straight line.

**Dipole radiation:** Sinuous oscillation along straight line, which generates dipole radiation pattern. Actually this type of radiation is utilized as radiofrequency wave, which plays key role of telecommunications systems, such as cell phones. In shorter wavelength, most of all visible radiations are from dipole motion of electrons in atoms, when it jumps from one quantum state to the others. Random zigzag motion of electrons also generates random electromagnetic radiation as thermal radiation (such as the heat from sun).

**Circle:** When electron runs in circular trajectory, it creates spiral pattern. This is the synchrotron radiation. Scientists use circular accelerator to generate synchrotron radiation at X-ray wavelength, which is very useful radiation to analyze materials. On the other hand, far galaxy, high-energy electrons are running with curved trajectory in the space magnetic field, generating visible light and also X-rays, known as cosmic synchrotron radiations, important radiation to study cosmology.

**Undulator:** When an electron passes through a periodic magnetic field produced “undulator”, it generates focused quasi-monochromatic X-ray beam, called undulator radiation. Modern synchrotron radiation facilities equipped many undulators, to produce high quality X-ray beams for various scientific analysis, most importantly analyze atomic structure of protein crystals.

**Racetrack:** Electron runs on racetrack trajectory. You may learn the radiation is only created from the curved trajectory, not from linear motion. Radiation is only generated by the accelerating motion of charged particle.

**Bending Magnet:** Incoming electron enters to bending magnet, suddenly start turning, and generates radiation. By looking carefully the field pattern along electron motion, you will find longitudinal field components in front of electron, which becomes source of CSR effect.