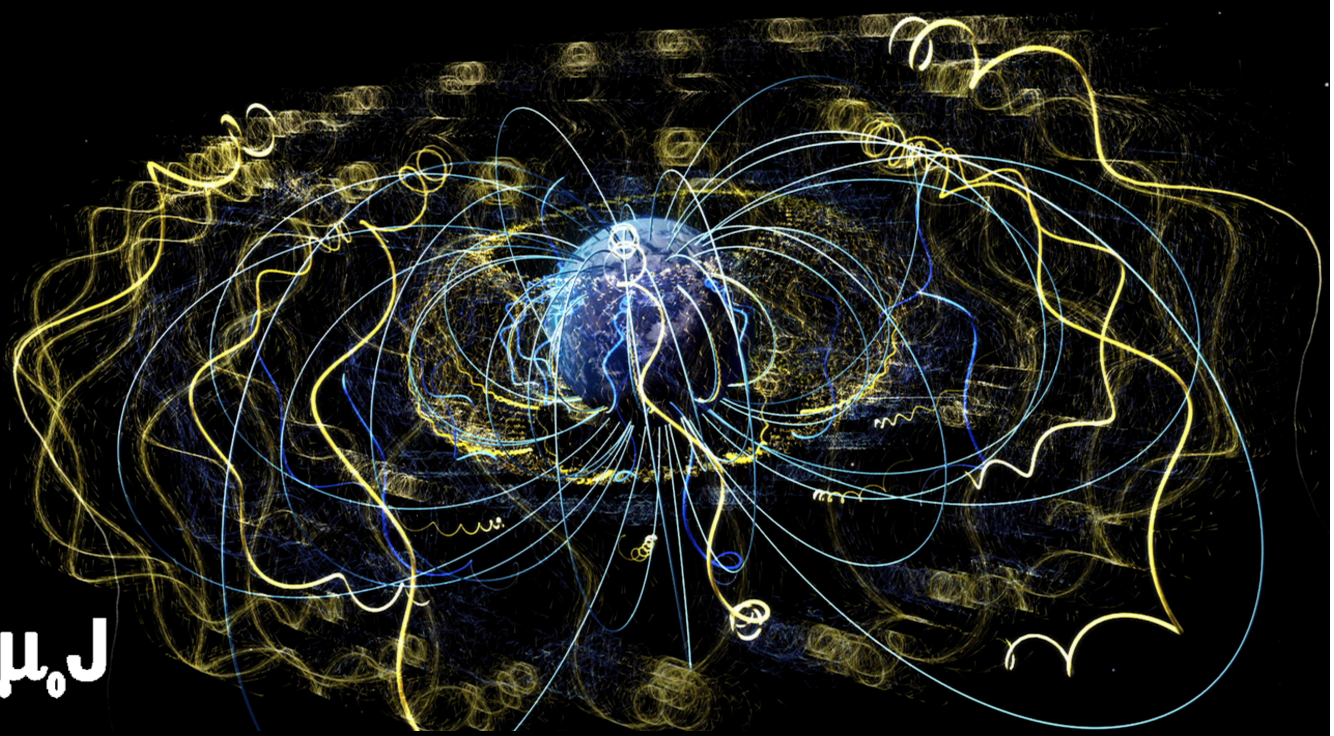
$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{B} = \mu_0 \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} + \mu_0 \mathbf{J}$$



Electricity and Magnetism I: 3811

Professor Jasper Halekas

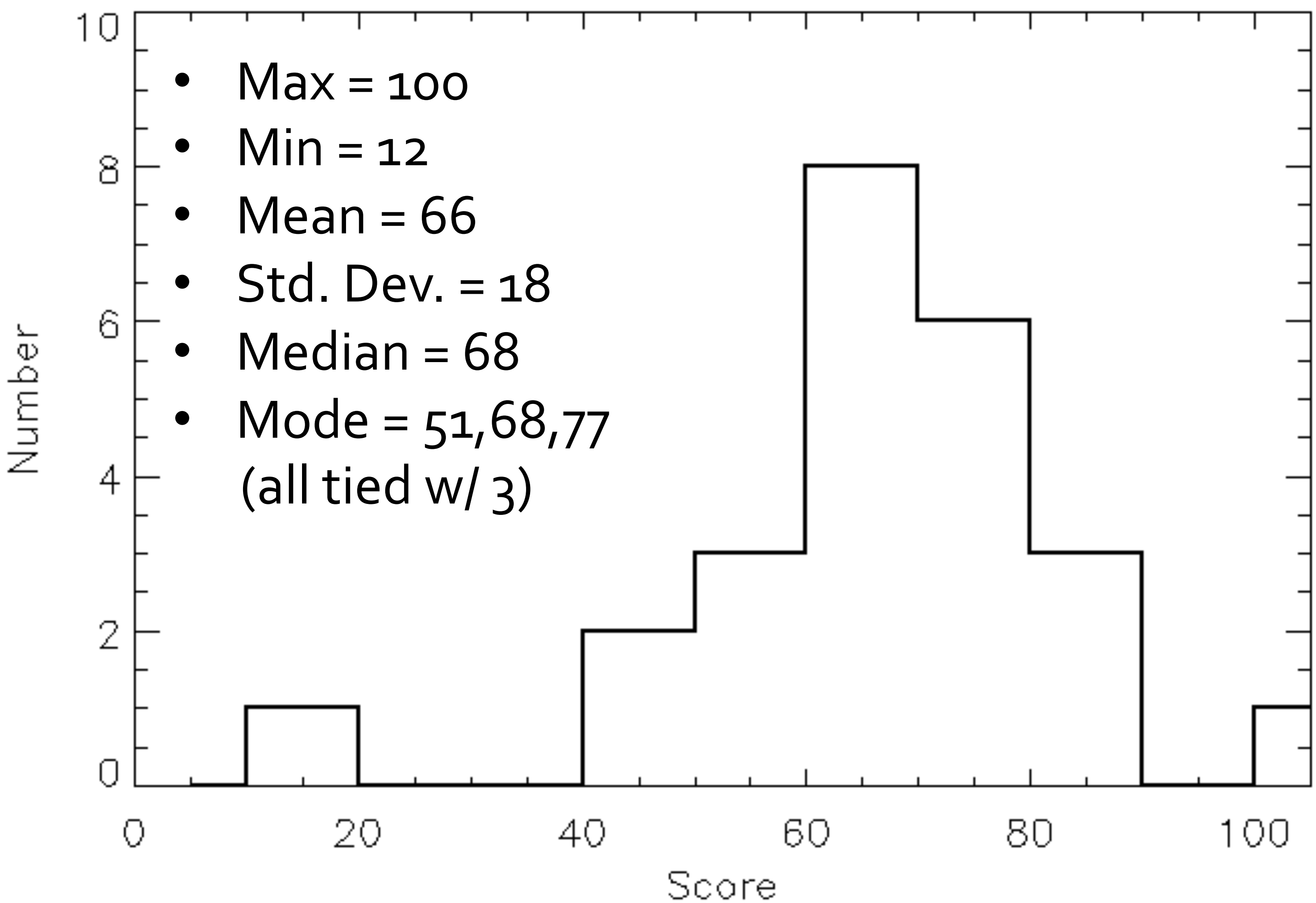
Van Allen 301

MWF 9:30-10:20 Lecture

Announcements

- I will be absent next Monday & Wednesday
  - Prof. Baalrud will substitute
- There is homework due next Friday

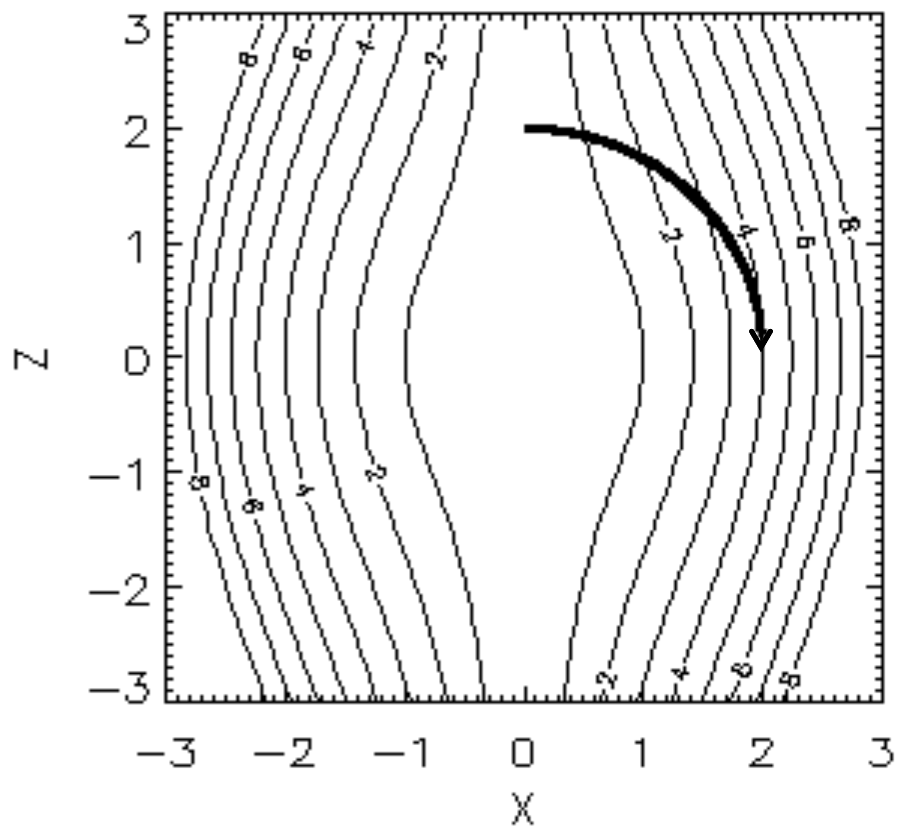
Midterm #1



Max = 100
Min = 12
Mean = 66
Std. Dev. = 18
Median = 68
Mode = 51,68,77
(all tied w/ 3)
Number
Score
0
2
4
6
8
10
0
20
40
60
80
100

Q1

- Line integrals
- Spherical coordinates
- Gradient theorem

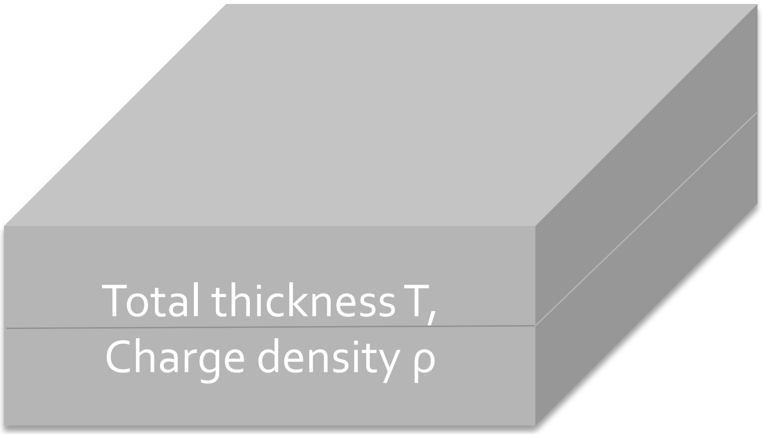


Q2

- Integrating over a delta function picks out the value of the multiplying function at the location of the delta function

Q3

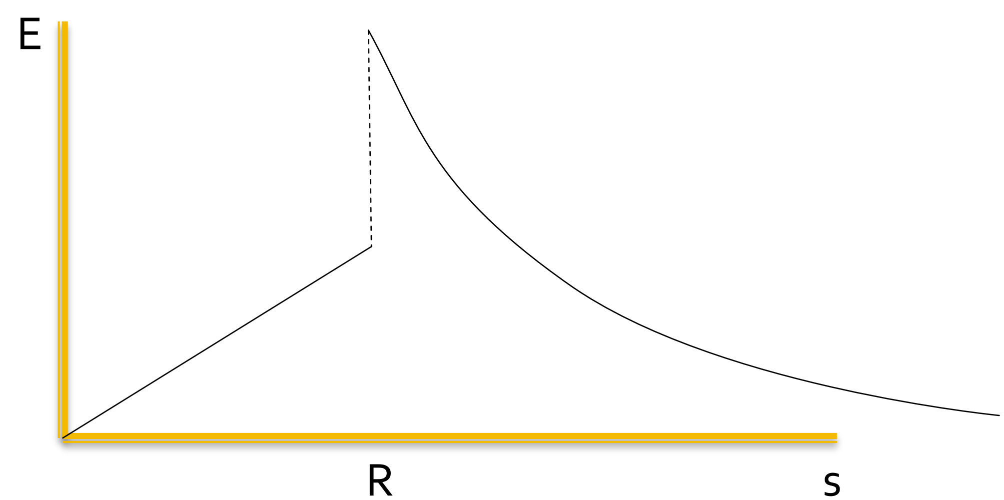
- Gauss's law: Integral form
- Cartesian coordinates
- Potential & work



Q4

- Gauss's law: Differential form

- Cylindrical coordinates
- Boundary conditions



General Eqs. for $\vec{E}$, V

$$\vec{E}(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\int \frac{\hat{\Delta r}}{\Delta r^2}\rho(\vec{r}\,')\,d\tau'$$
$$V(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\int \frac{1}{\Delta r}\rho(\vec{r}\,')\,d\tau'$$
} cumbersome!

Gauss's Law: $\nabla\cdot\vec{E} = \rho/\varepsilon_0$

$\Rightarrow$ Poisson's Eq. $\nabla^2 V = -\rho/\varepsilon_0$

Charge-free Region

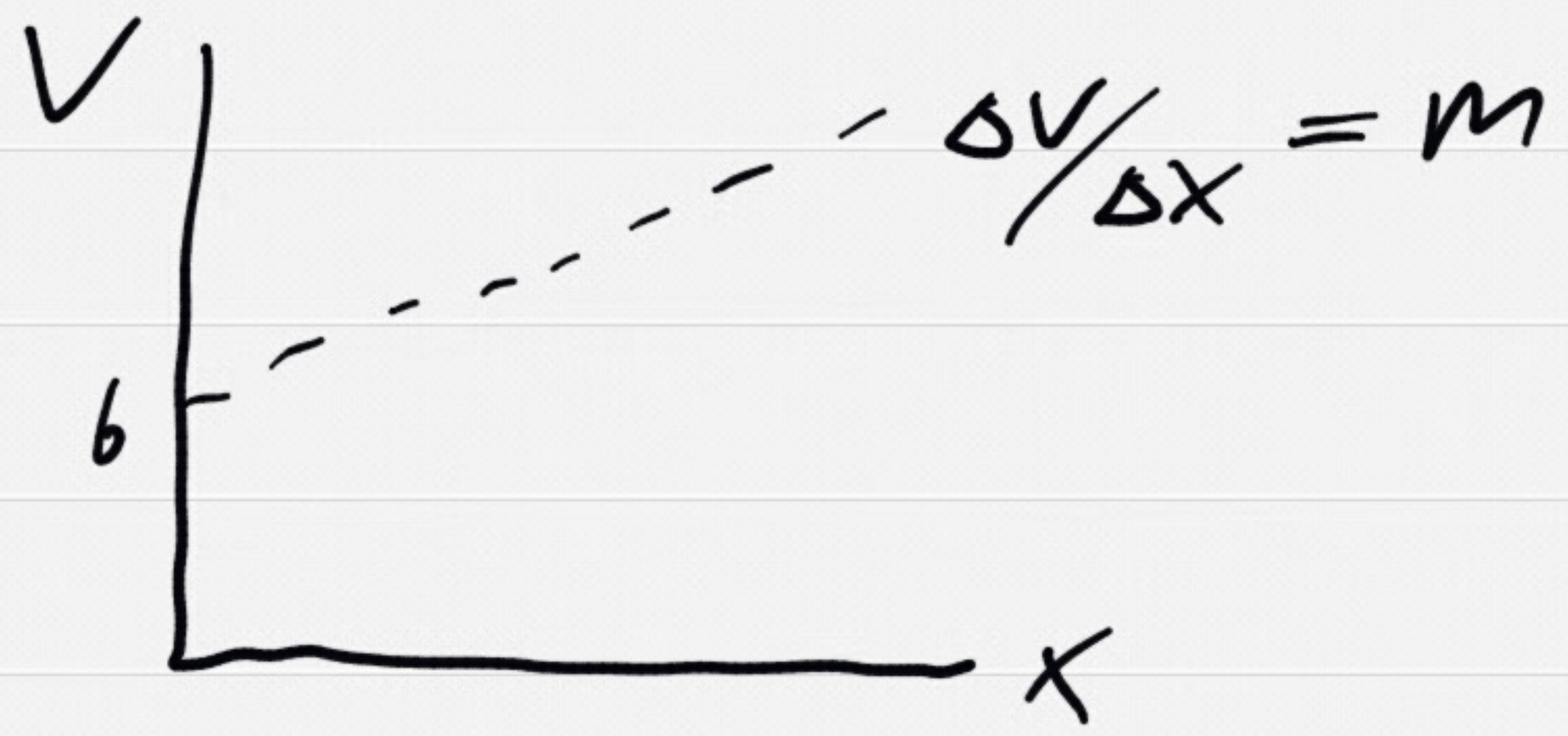
$\Rightarrow$ Laplace's Eq. $\nabla^2 V = 0$

Cartesian:

$$\nabla^2 V = \partial^2 V/\partial x^2 + \partial^2 V/\partial y^2 + \partial^2 V/\partial z^2 = 0$$

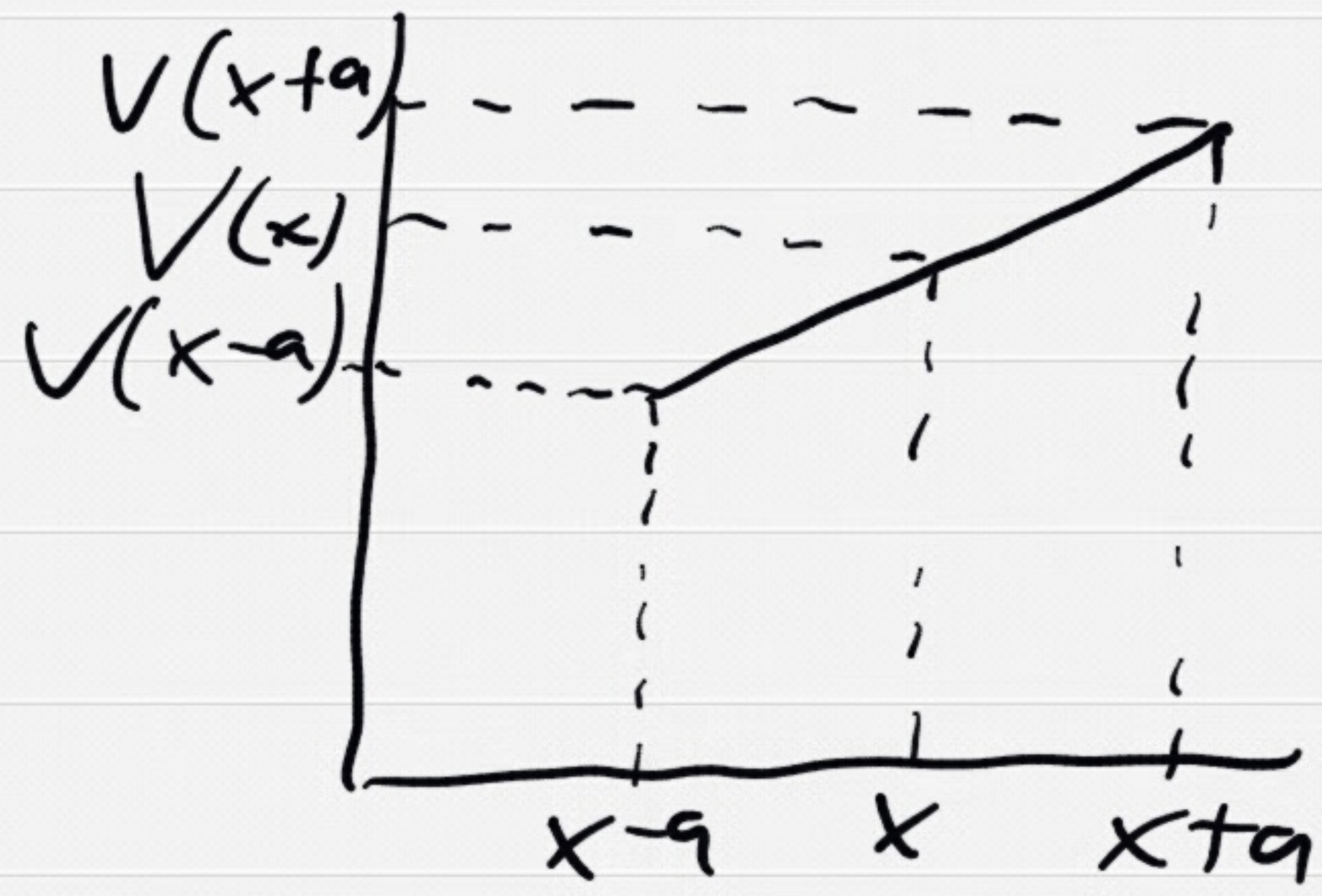
Laplace's Eq. in 1-D

$$\frac{d^2V}{dx^2} = 0 \Rightarrow V(x) = mx + b$$



Interesting Fact:

$$V(x) = \frac{1}{2}\left[V(x-a) + V(x+a)\right]$$



$$\begin{aligned} V(x) &= \frac{1}{2}\left[V(x-a) + V(x+a)\right] \\ &= \frac{1}{2}\left[m(x-a) + b + m(x+a) + b\right] \\ &= mx + b \end{aligned}$$

Zero curvature $\Rightarrow$
No local extrema
(except at endpoints)

Laplace's Eq. In 2-d

$$\partial^2 V / \partial x^2 + \partial^2 V / \partial y^2 = 0$$

$$V(x, y) = \frac{1}{2\pi R} \oint V \, dl$$

around a circle centered at (x, y)

- V has no local extrema except on boundaries

Laplace’s Equation