

Rate Models Fail

because

**Current-in
does not equal
Current-out!!**

(if rate constants are independent of potential)



$$I_{AB} \neq I_{DE}$$

but **Kirchoff Current Law** (*i.e., Maxwell Eqns*)

requires

$$I_{AB} = I_{DE}$$

More specifically



$$I_{AB} = \vec{k}_{AB}[A] - \vec{k}_{AB}[B]$$

$$I_{DE} = \vec{k}_{DE}[D] - \vec{k}_{DE}[E]$$

In general $I_{AB} \neq I_{DE}$

The discussion assumes the reactants A, B, \dots are at different spatial locations.

The discussion assumes reactants are charged,
as they almost always are with fixed and/or permanent dipole charges

Parameterization is not Possible

under more than one condition

Rate constants chosen at one charge or one potential
cannot work for different charges or potentials.

**Different charges or potentials will
change the currents
in the real world**

but

**Currents in the Rate Models
are
Independent of Charge and
Potential**

Kirchoff Current Law

requires

$$I_{AB} = I_{DE}$$

ALWAYS

$\pm 10^{-17}$, or so

**Kirchoff Current Law
and
Maxwell Equations
are nearly the same thing**

Bhat & Osting (2011). IEEE Trans Antennas and Propagation 59: 3772-3778.

Heras (1991) American Journal of Physics 59: 111-117

Heras. (2007) American Journal of Physics 75: 652-657

Heras (2011) American Journal of Physics 79: 409

Itzykson & Zuber Quantum Field Theory (1990) p. 10

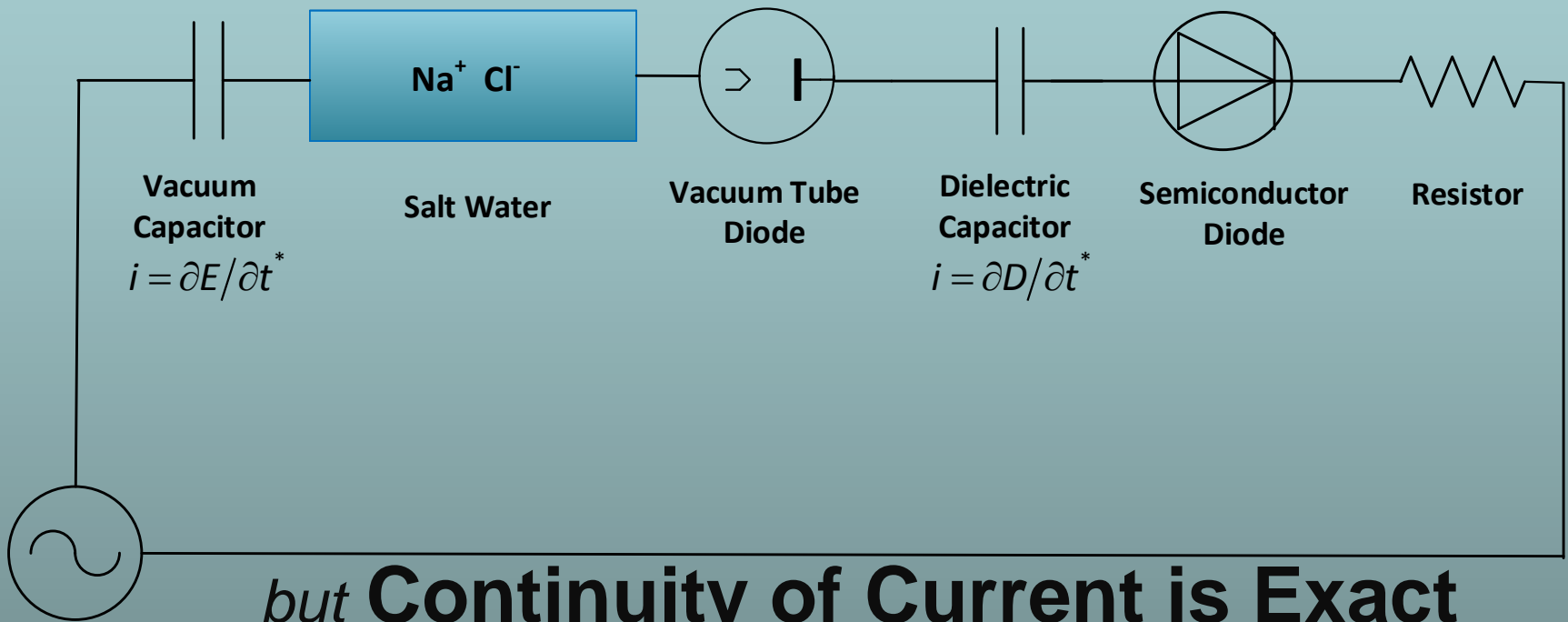
Continuity of Current is Exact

even though
**Physics of Charge Flow
Varies Profoundly**

*Maxwell Equations are
Special*

**‘Charge’ is an Abstraction
with
VERY different Physics
in different systems**

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but **Continuity of Current is Exact**
No matter what carries the current!

* metaphorical equations: displacement field $D = \text{permittivity} \times E$

Continuity of Current is Exact

even though

Physics of Charge Flow

Varies Profoundly

even

Creating Plasmas

in air

Sparks



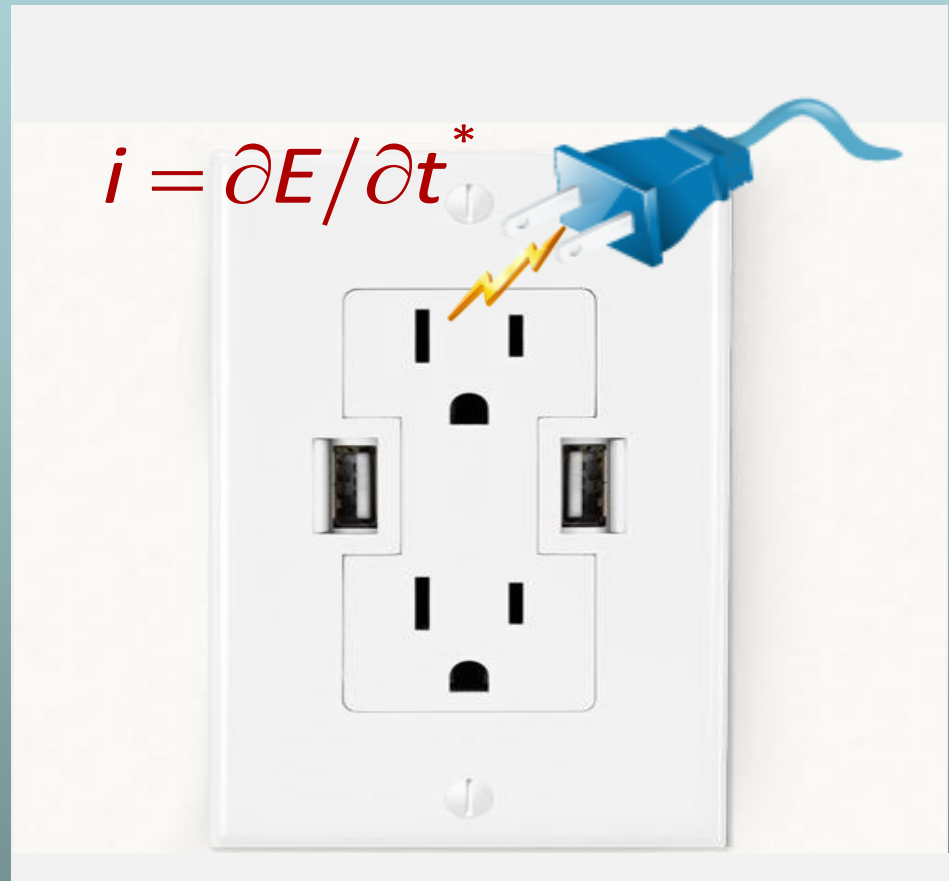
Mathematics of Continuity

in Maxwell equations can

Create New Kind of Physics, New Kind of Charge

*When we unplug a
computer power supply,
we often
CREATE
SPARKs ,
i.e., a PLASMA,*

*a NEW KIND
of current flow*



***speaking loosely**

Maxwell Equations are Special

Continuity of Current is Exact

no matter what carries the current

even though

**Physics of Charge Flow
Varies Profoundly
even Creating Plasmas!**



**'Charge' is an Abstraction
with
VERY different Physics
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