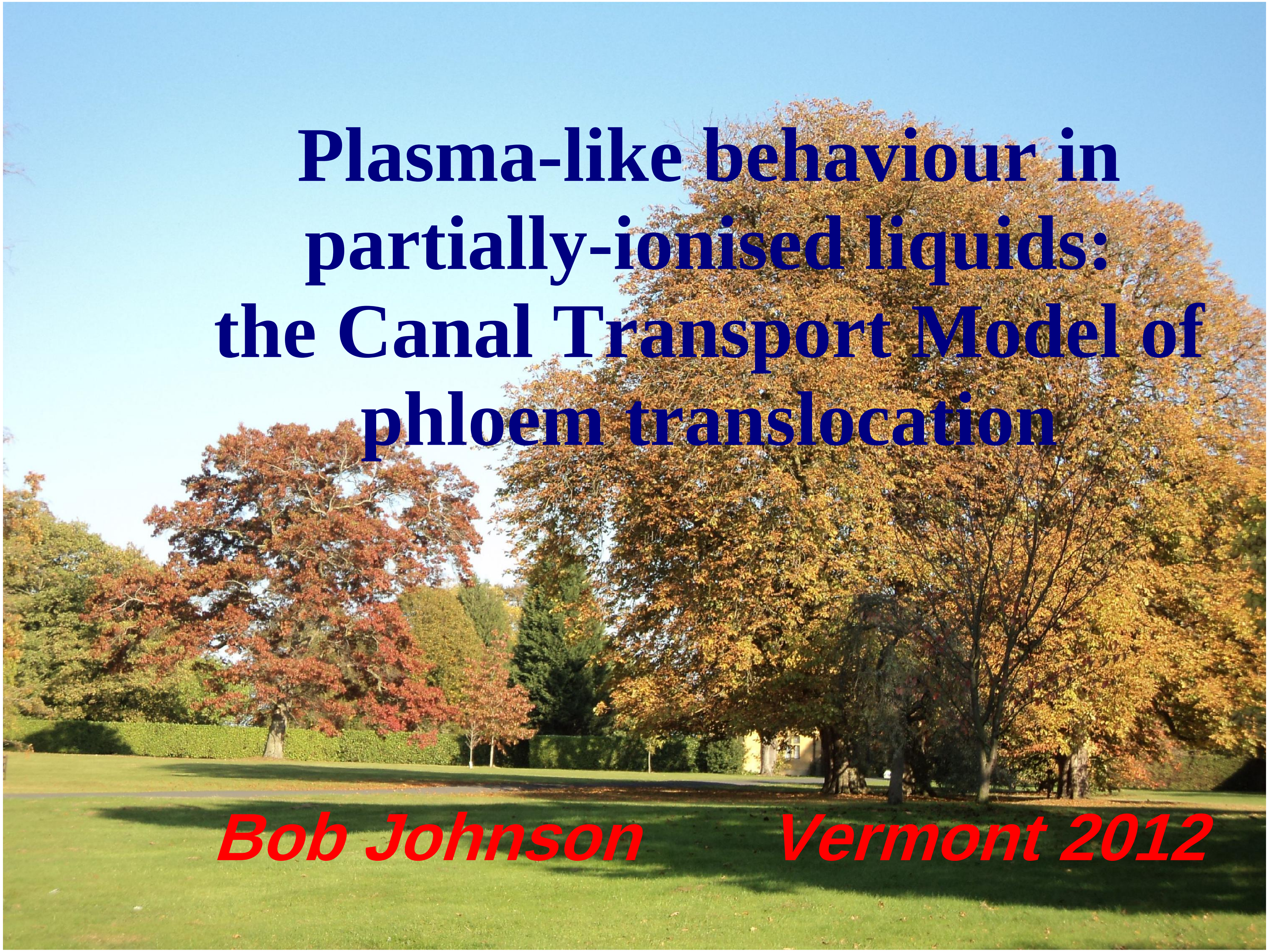


Plasma-like behaviour in partially-ionised liquids: the Canal Transport Model of phloem translocation

Bob Johnson Vermont 2012

Q: Why was ionised gas named after blood plasma ?

Q: Why was ionised gas named after blood plasma ?

A: Because its behaviour is so lifelike!

Part I

Plasma-like behavior in:

The Floating Water Bridge

Plasma in space

Part II

Plasma-like Behavior + EZ water in

Sucrose transport in trees:

The Canal Transport Model

The Floating Water Bridge

See http://www.ecfuchs.com/?page=waterbridge for original movie

Image Credit: Fuchs/Woisetschläger *2010*

Rotation in the Bridge

See http://www.youtube.com/watch?v=Gozw-TxeX9w for original movie

Image Credit: Fuchs/Woisetschläger *2010*

Annulus and Core
Bi-directional water flows

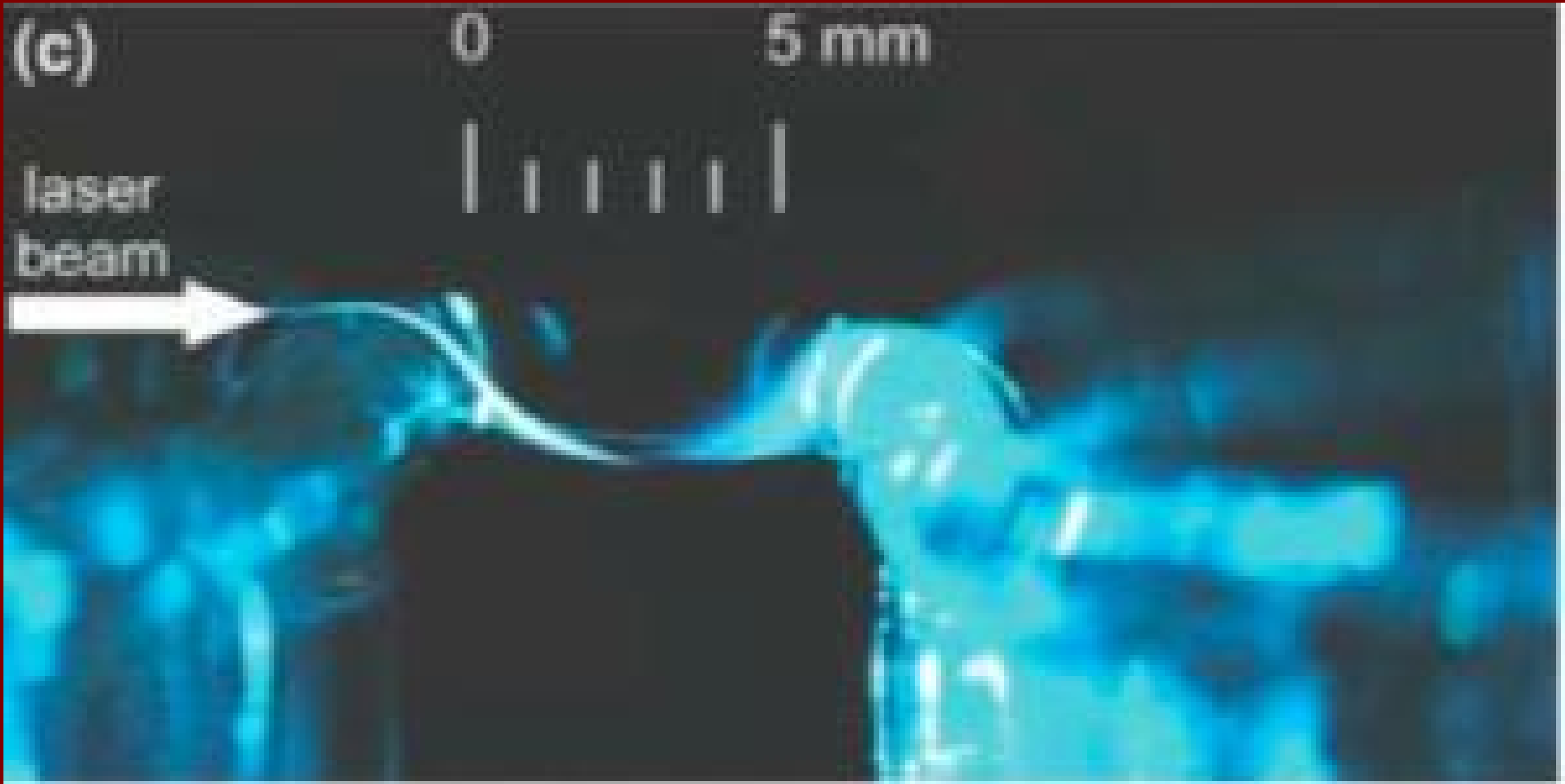


Image Credit: Fuchs/Woisetschläger *2010*

Charge Transport During the Experiment

Image Credit: Fuchs/Woisetschläger *2010*

Charge Transport
After the Experiment

Image Credit: Fuchs/Woisetschläger *2010*

Features of the FWB

Cylindrical tube

Annulus and Core structure

Bi-directional flow of water and charge

Rotating Annulus

Positive Annulus; Negative Core

Features of the FWB

- Cylindrical tube
- Annulus and Core structure
- Bi-directional flow of water and charge
- Rotating Annulus
- Positive Annulus; Negative Core

Plasma in Space

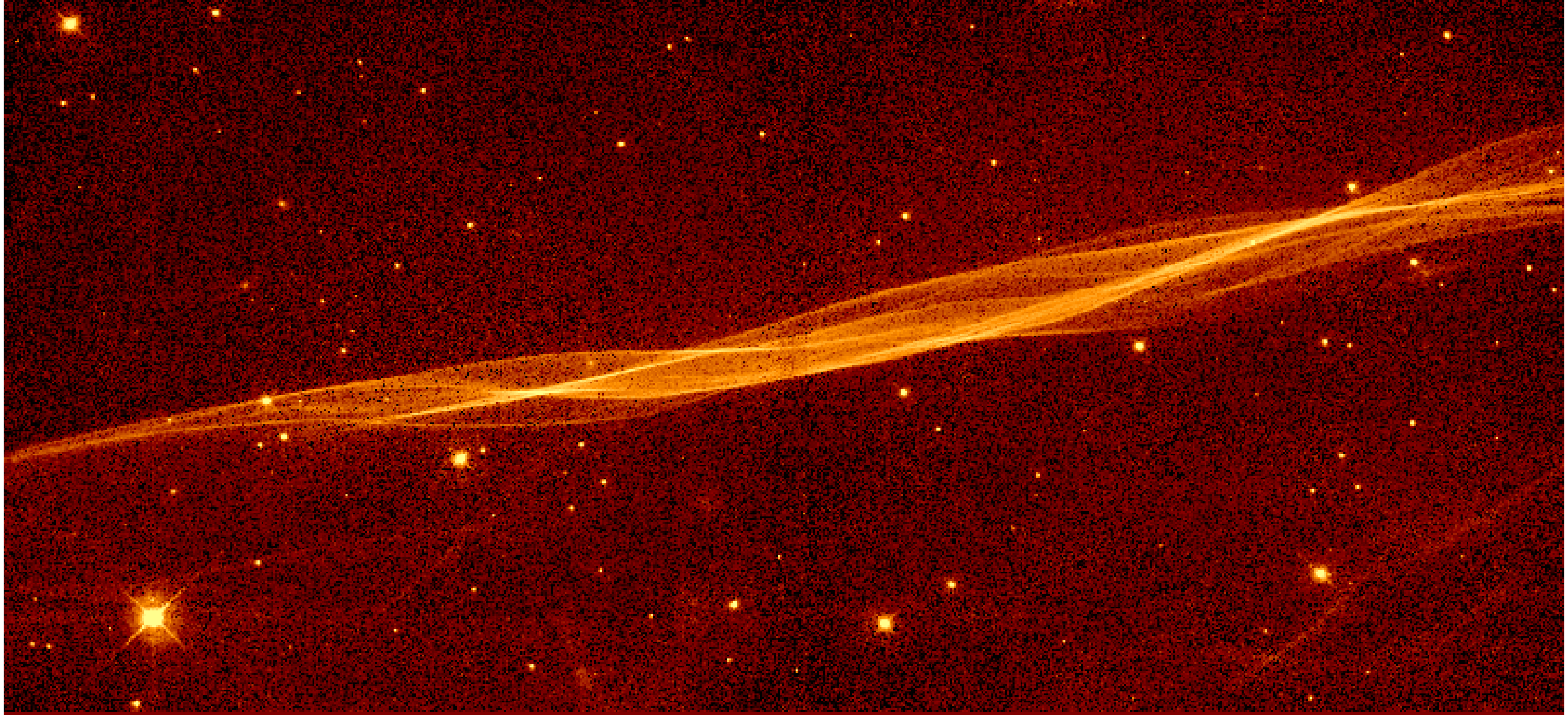


Image Credit: William P. Blair and Ravi Sankrit (Johns Hopkins University), NASA

Plasma Birkeland Currents

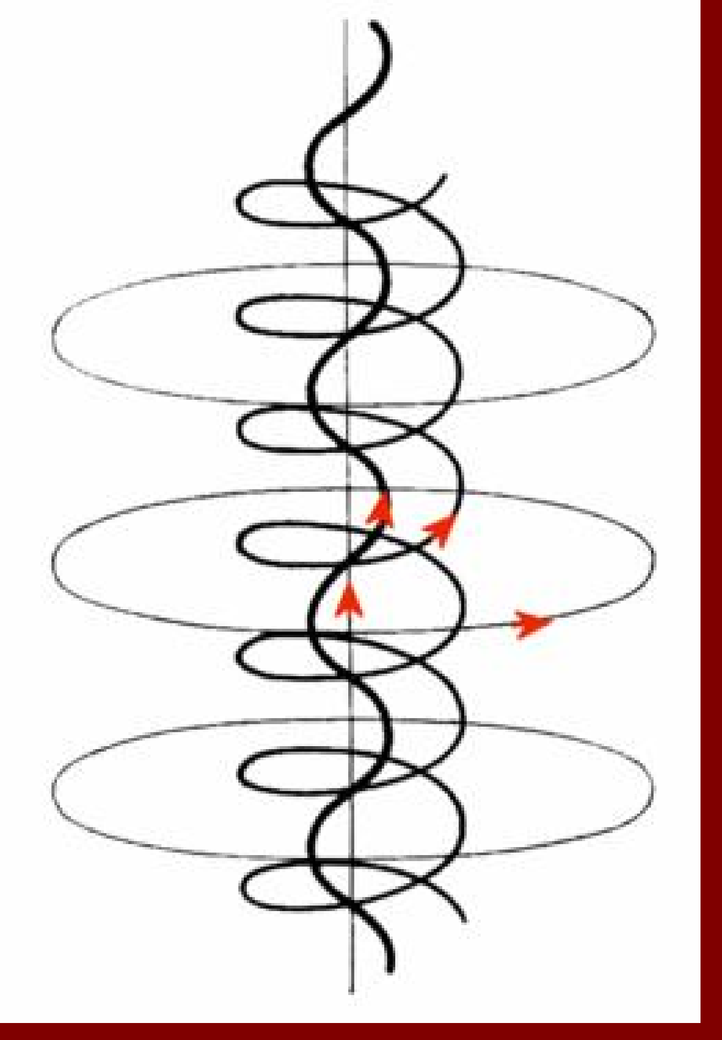


Image Credit: Wikipedia after Peratt PPU Fig 4.28

A Birkeland Current has:

Annulus and Core structure

Efficient bi-directional flow

Spiralling outer layers

Radial charge separation

A Birkeland Current has:

Annulus and Core structure

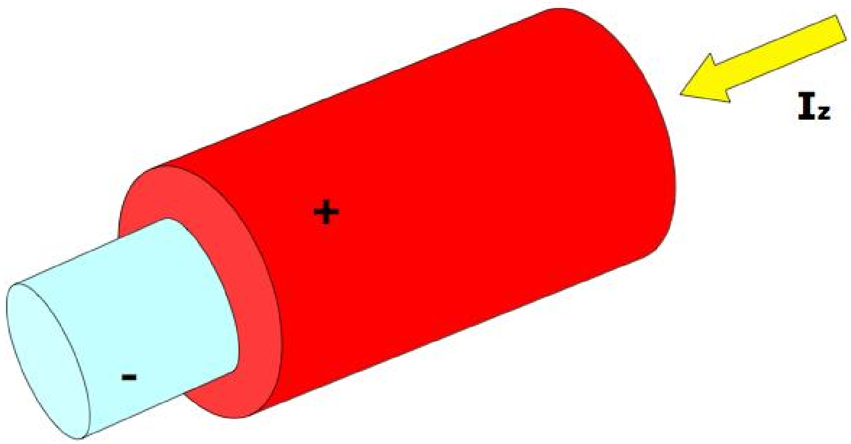
Efficient bi-directional flow

Spiralling outer layers

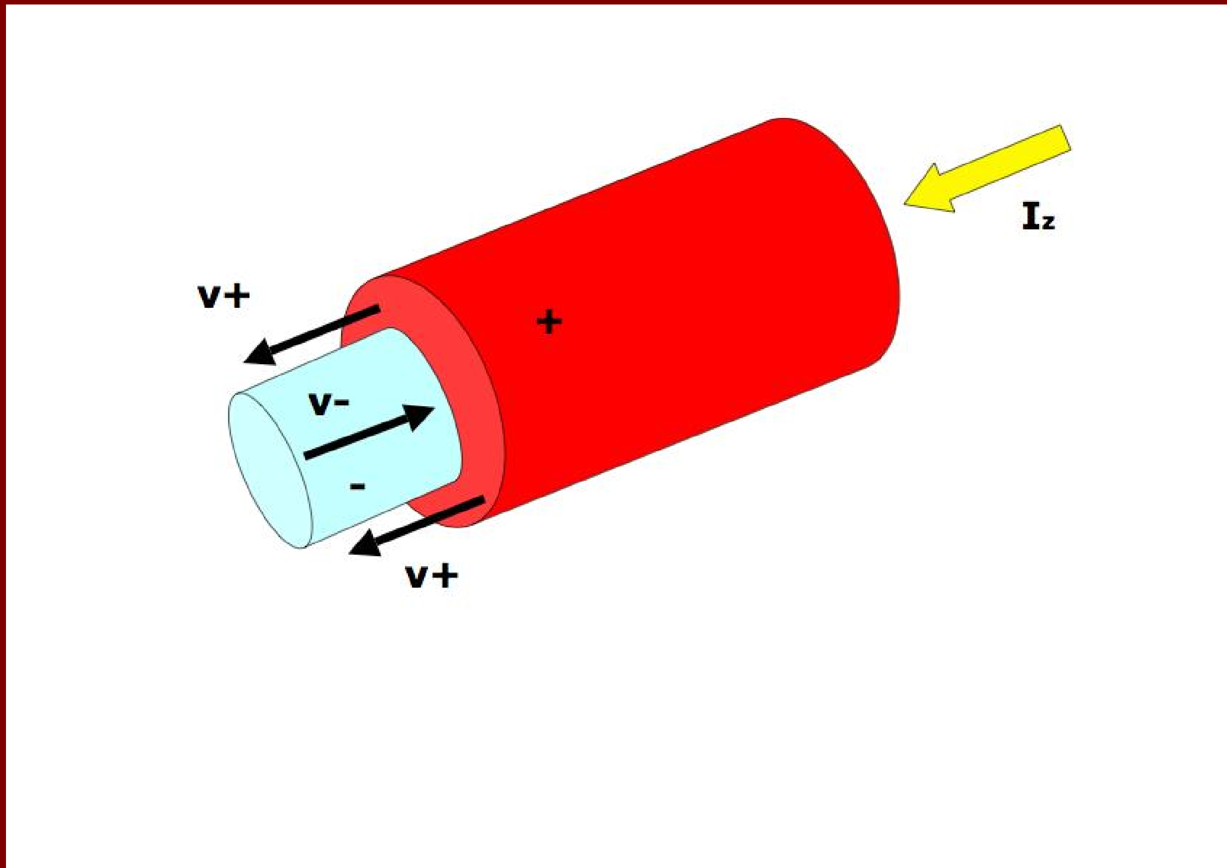
Radial charge separation

= the missing bits of FWB analyses?

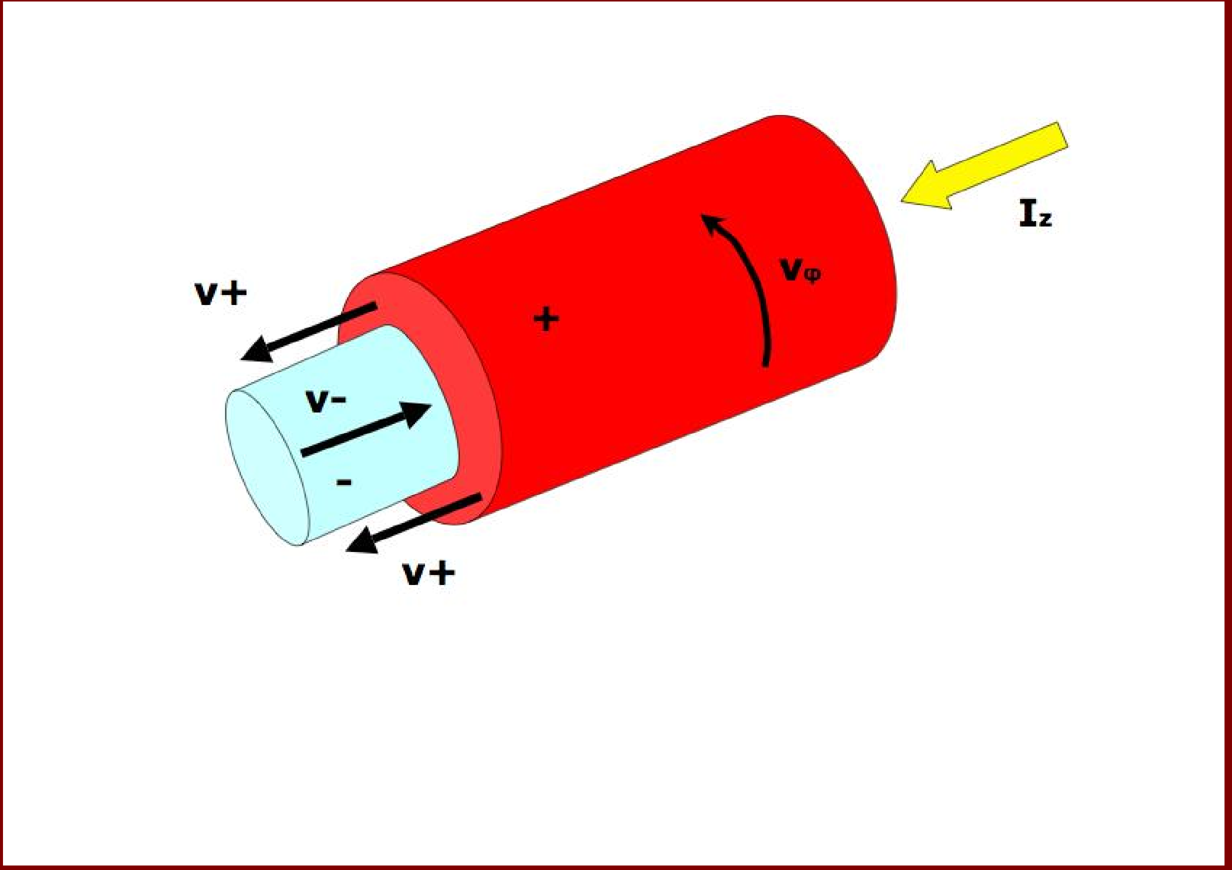
Charge-separated Annulus & Core



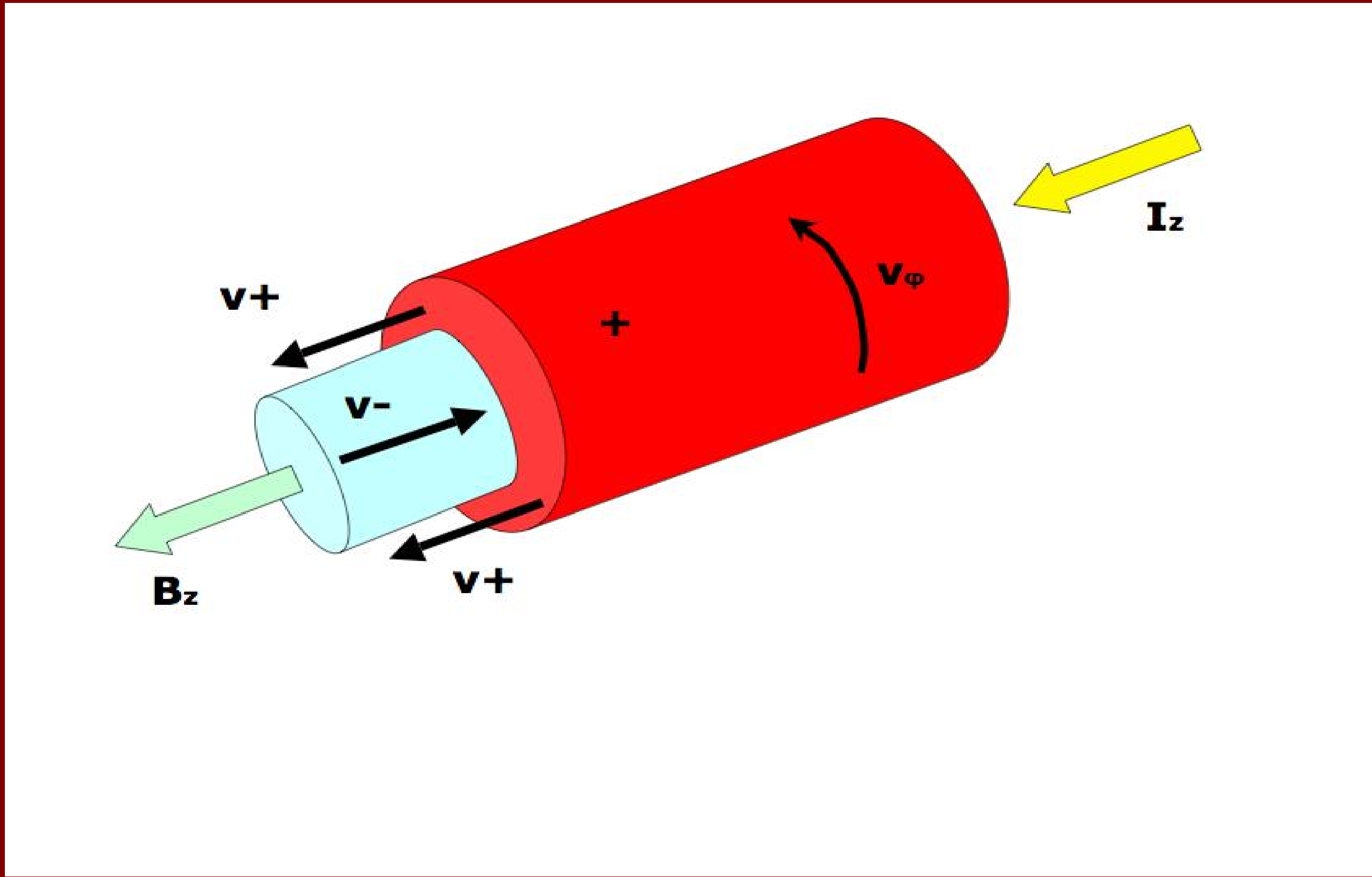
+ Bi-directional flow



+ Rotation of Annulus



+ Axial Magnetic Field



The FWB behaves like a Birkeland Current

We’ve shown that:

Plasma-like behavior

occurs in partially-ionized water

in the Floating Water Bridge.

Radial charge distribution is important.

Part II

Plasma-like Behavior + EZ water in

Tree Sap flow - The Canal Transport Model

EZ water in a tube

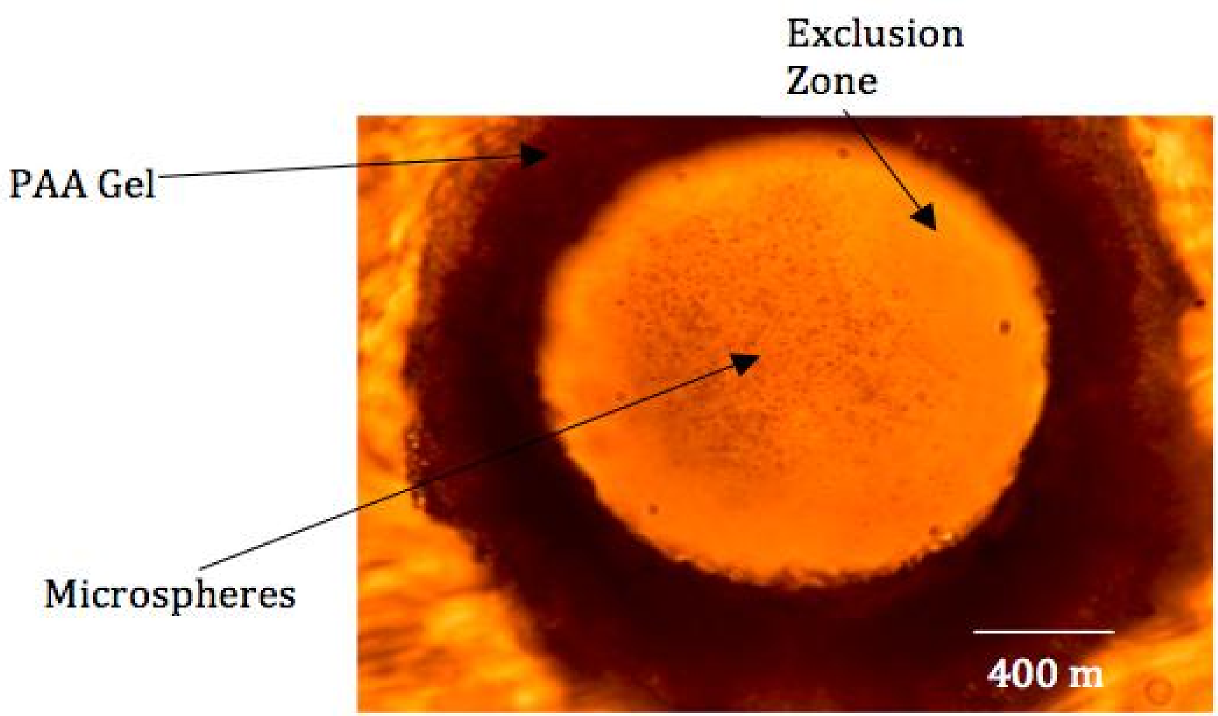


Figure 5b: Cross-sectional view showing annular exclusion within PAA tunnel.

Image Credit: Yu, Carlson & Pollack, 2011

Phloem Translocation

The ***Standard Model:***

Osmotically-Generated Pressure Flow

(***Münch 1927)***

Sieve tube elements & sieve plates

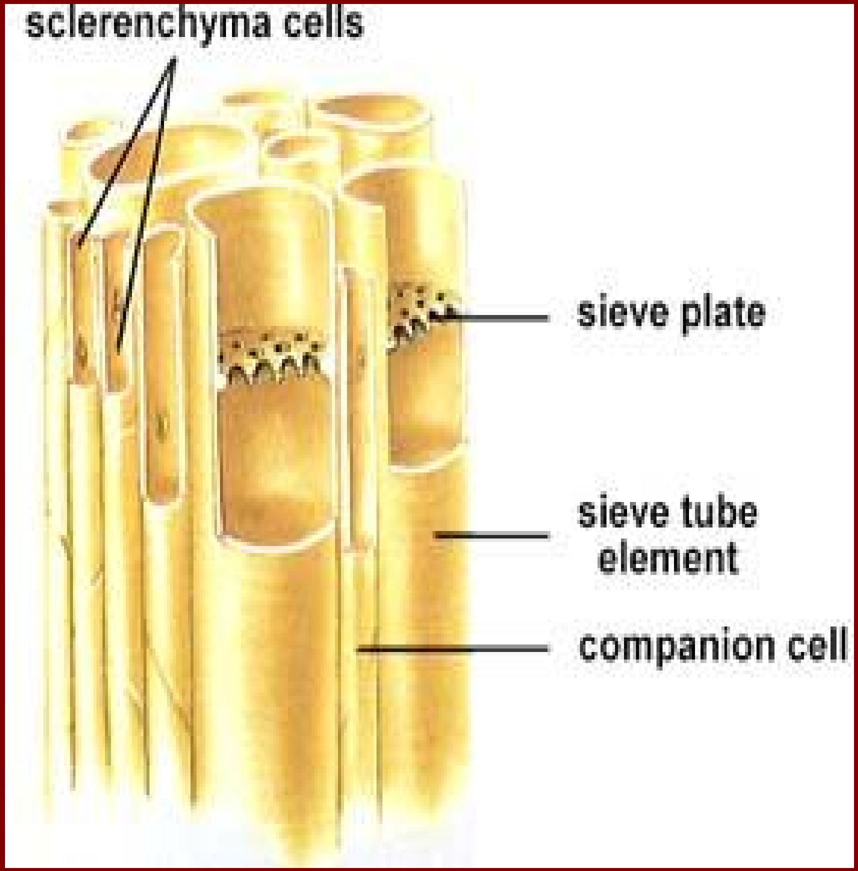
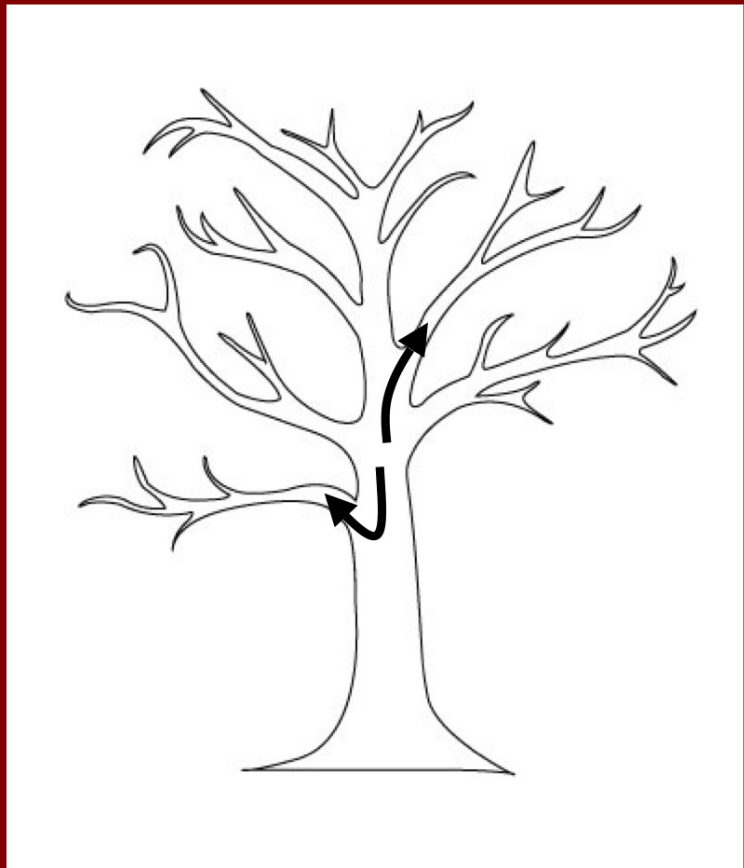


Image copyright: http://www.biosci.uga.edu/almanac/bio via http://ridge.icu.ac.jp/biobk/BioBookPLANTANAT.html

Flow up & down the tree



Bi-directional flow
in one sieve tube element ?

Image credit: FreakingNews.com

The Canal Transport Model of Phloem Translocation

by

Bob Johnson & Martin Canny

Sucrose molecule & hydration

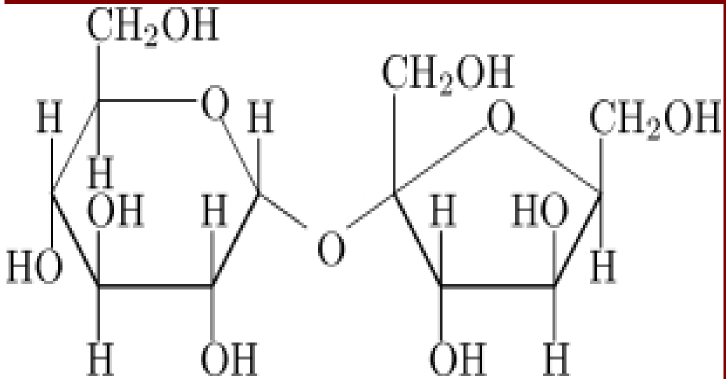
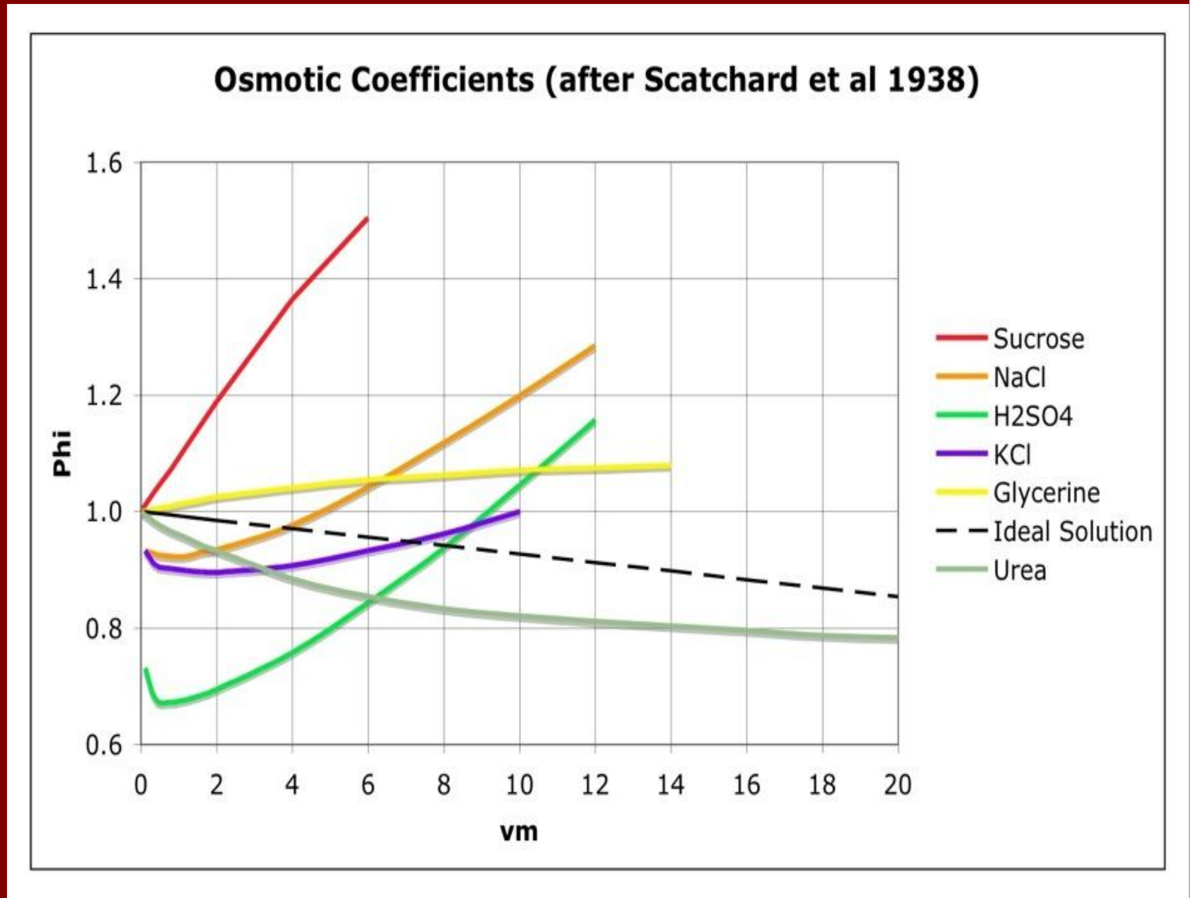
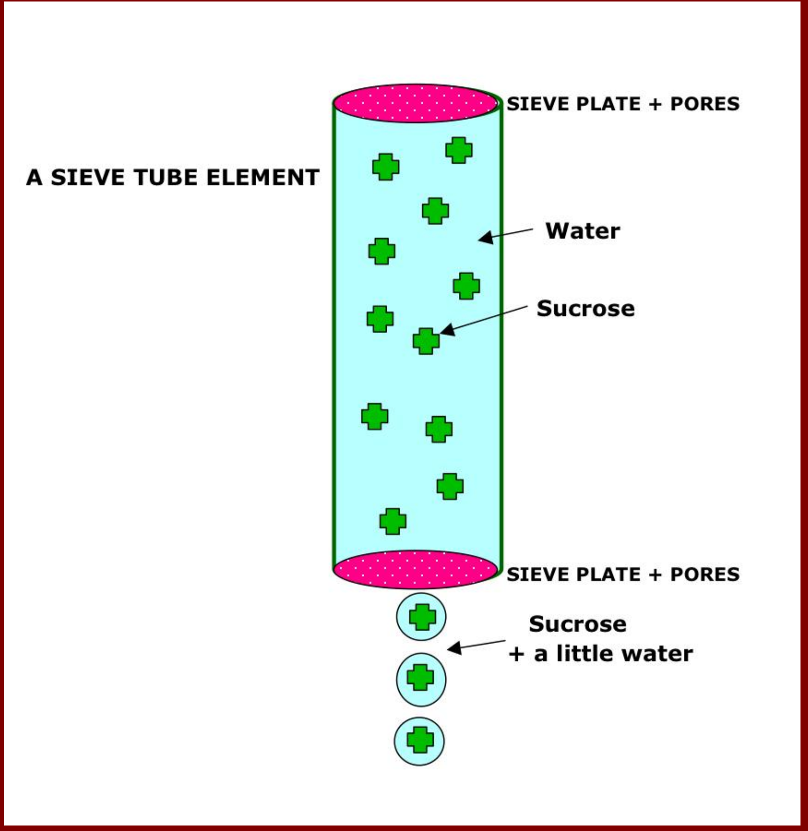


Image credit:
http://www.worldofmolecules.com/foods/sucrose.htm



After Scatchard, Hamer & Wood, 1938, Fig. 2

A more efficient mechanism



Sucrose passes through the sieve plate pores

Most of the water stays behind

The Canal Transport Model

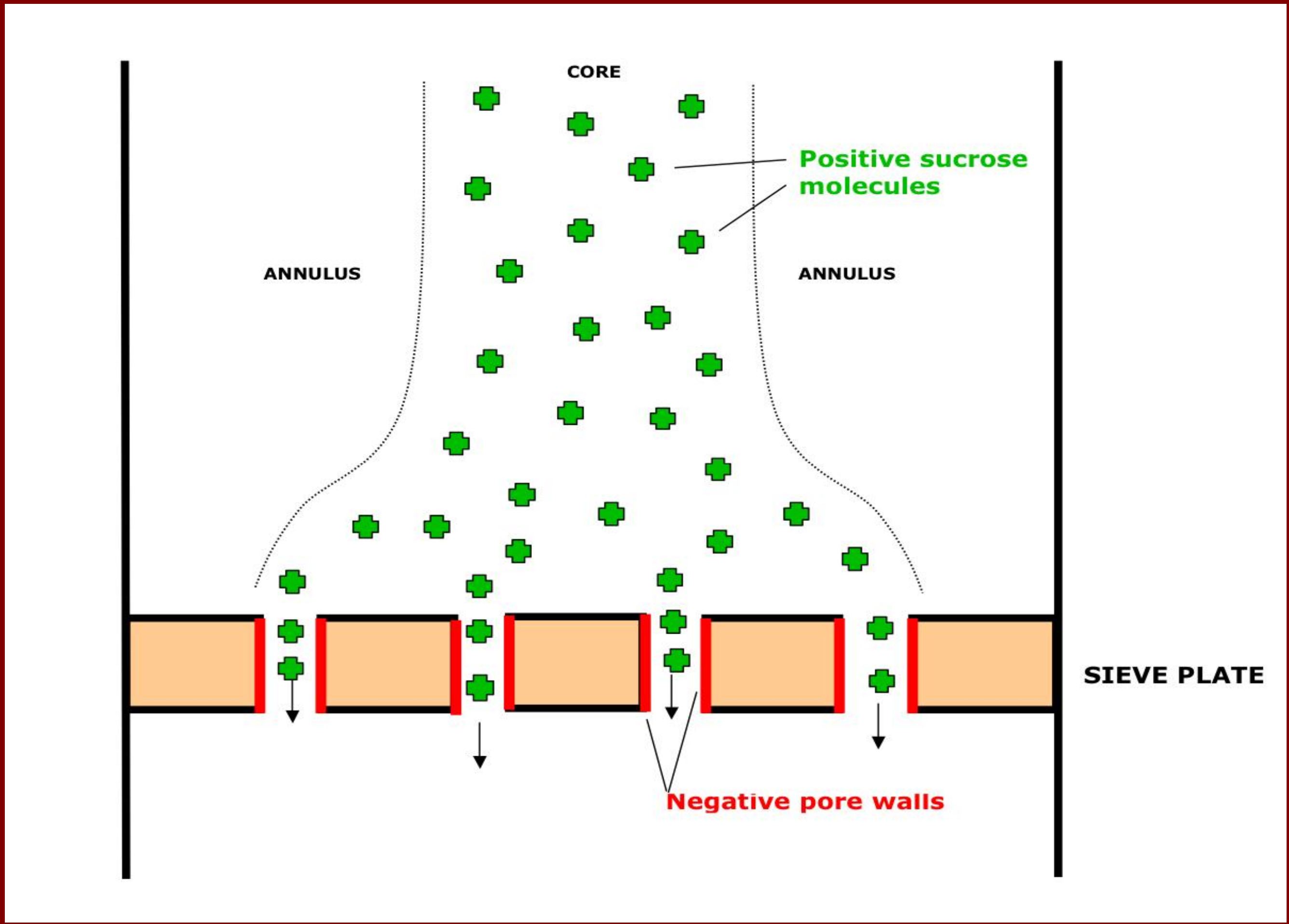
Sucrose = canal boat

Sieve plate pore = lock

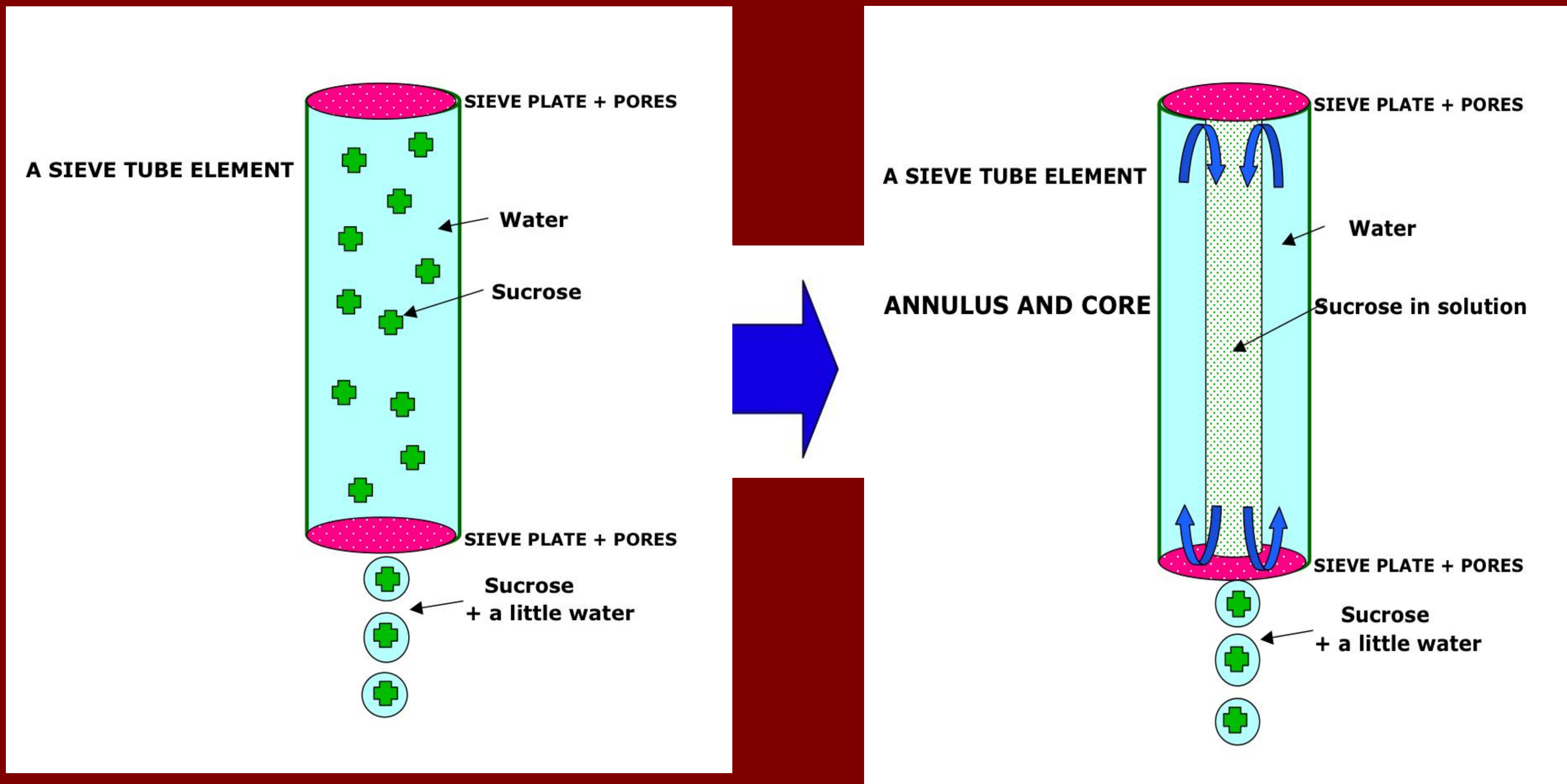
Coulomb repulsion drives the 'boat'

Image credit: www.thepanamadigest.com

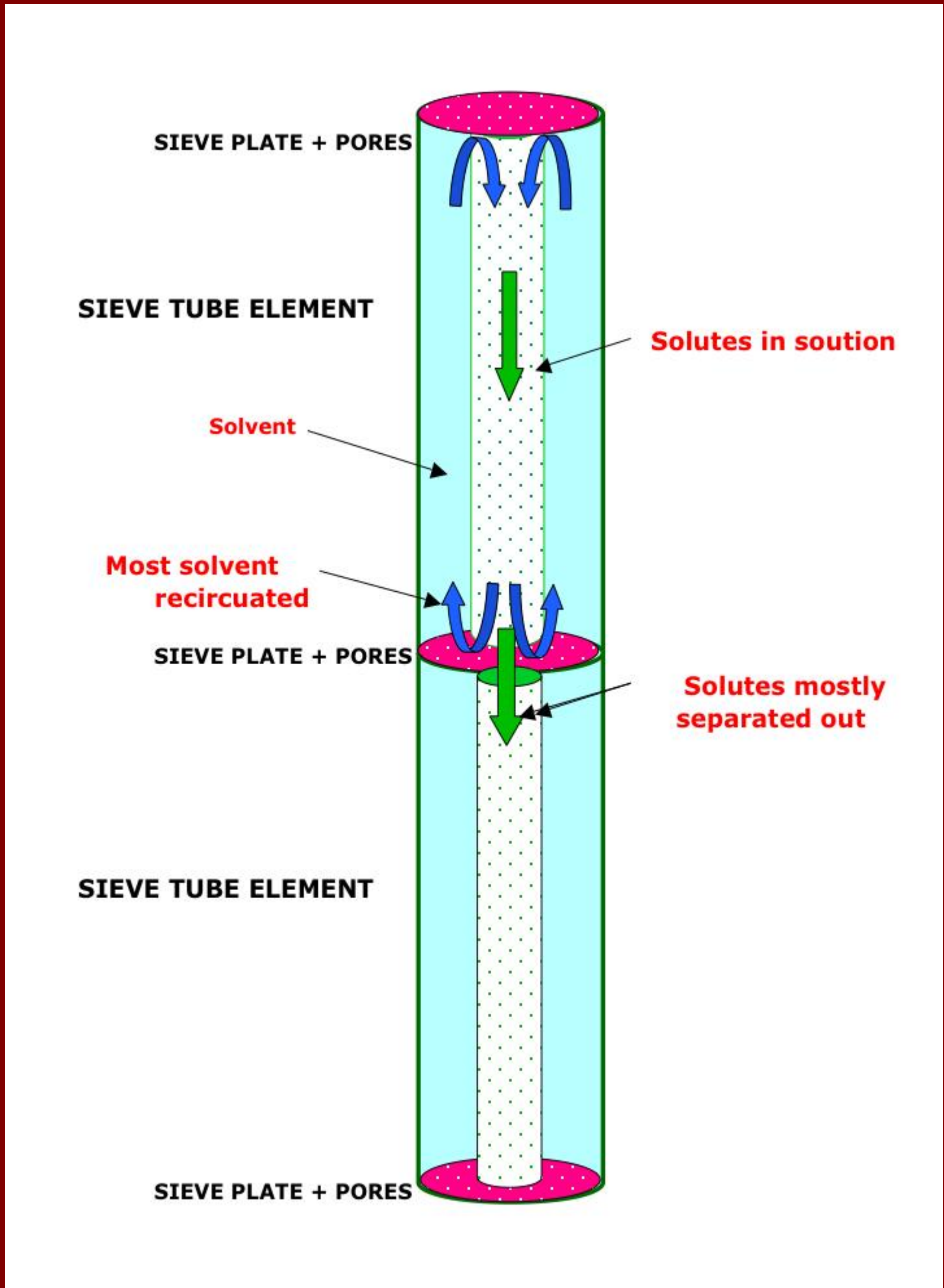
Sieve plate pores + EZ layers



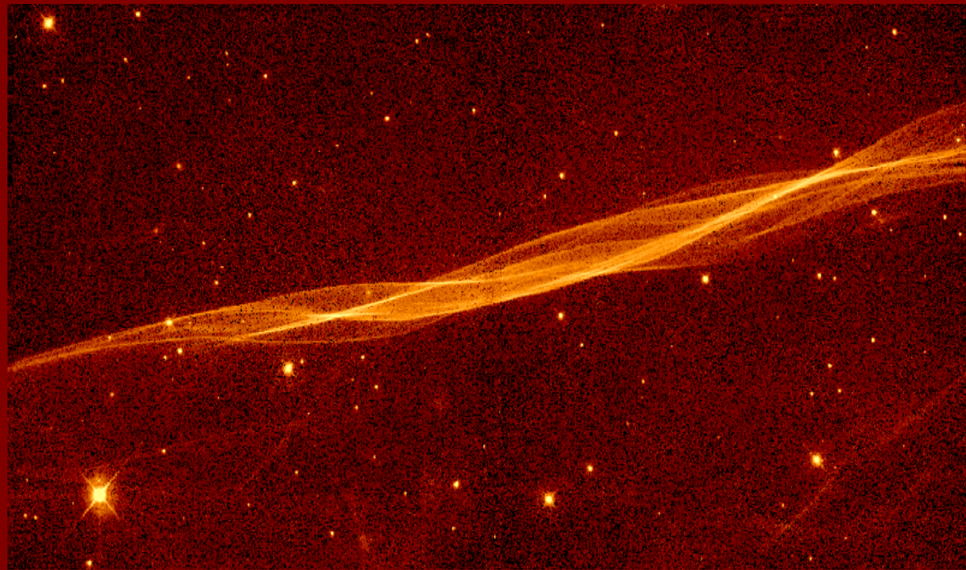
Sieve Tube + Annulus & Core



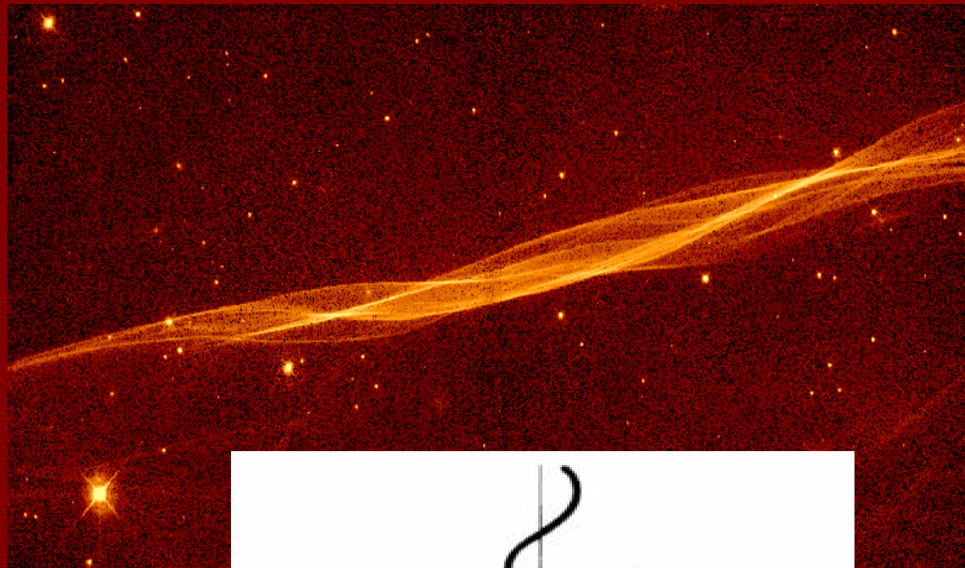
The Canal Transport Model

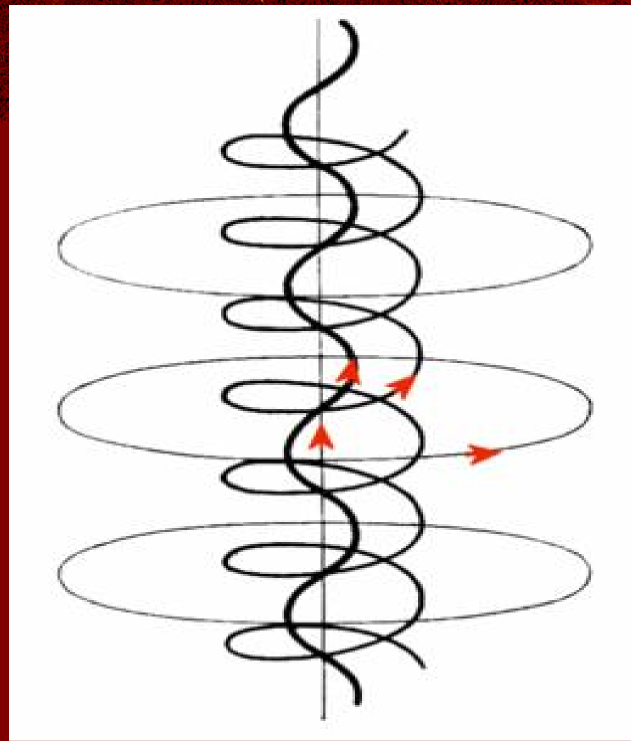


Radial Charge Distribution

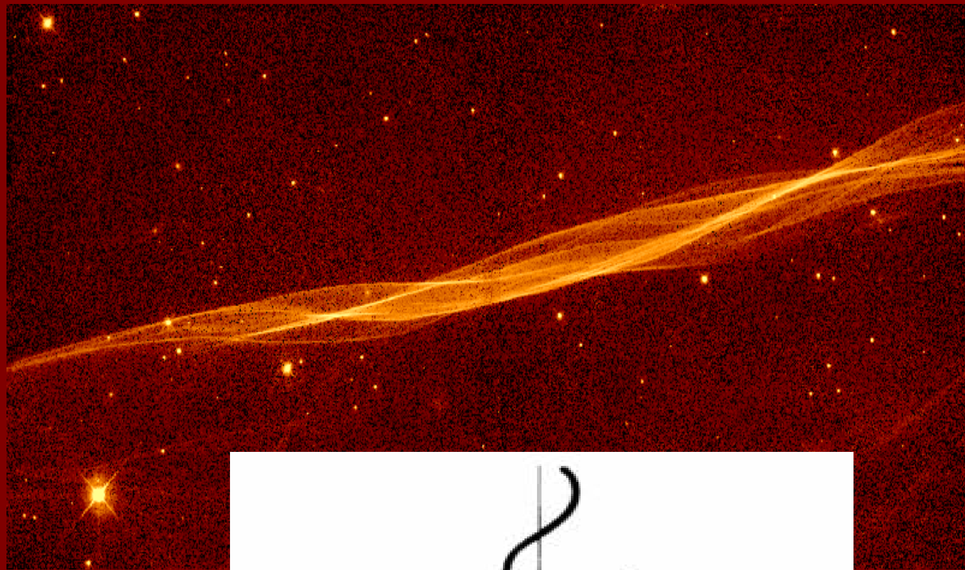


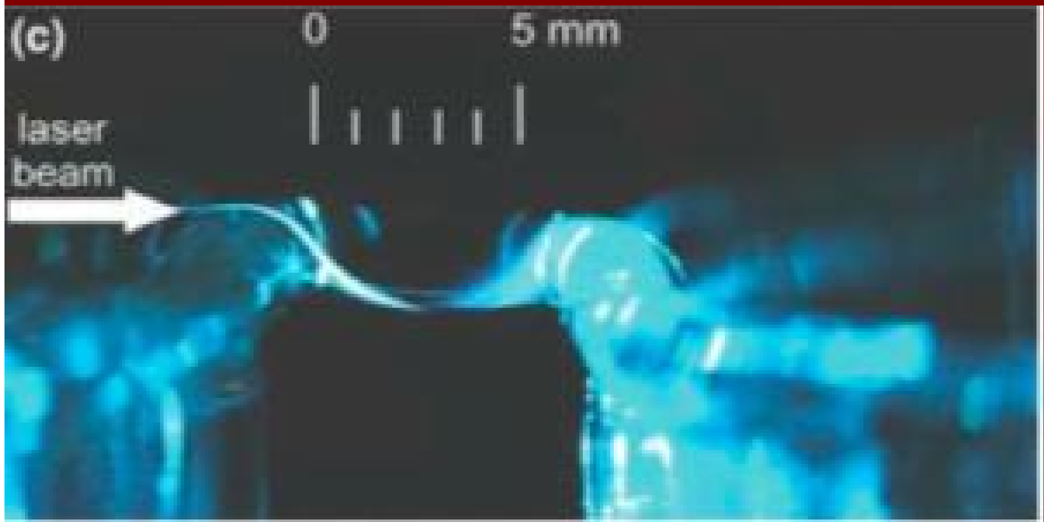
Radial Charge Distribution

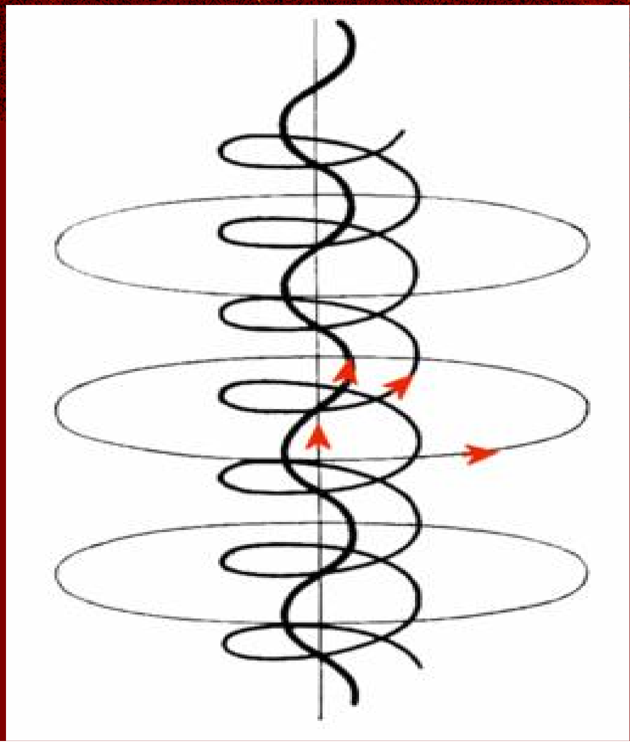




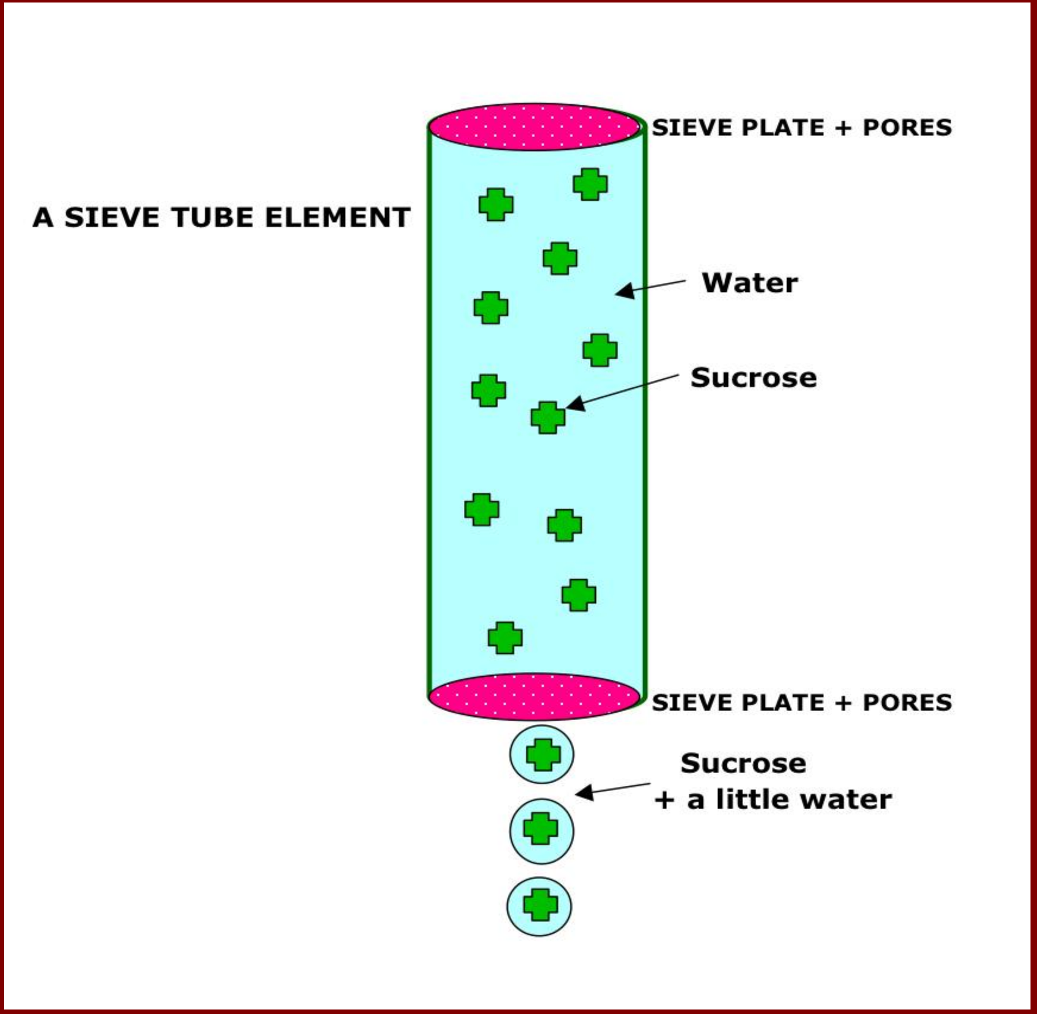
Radial Charge Distribution







The Canal Transport Model
Basic Model



Annulus & Core arrangement allows bi-directional flows

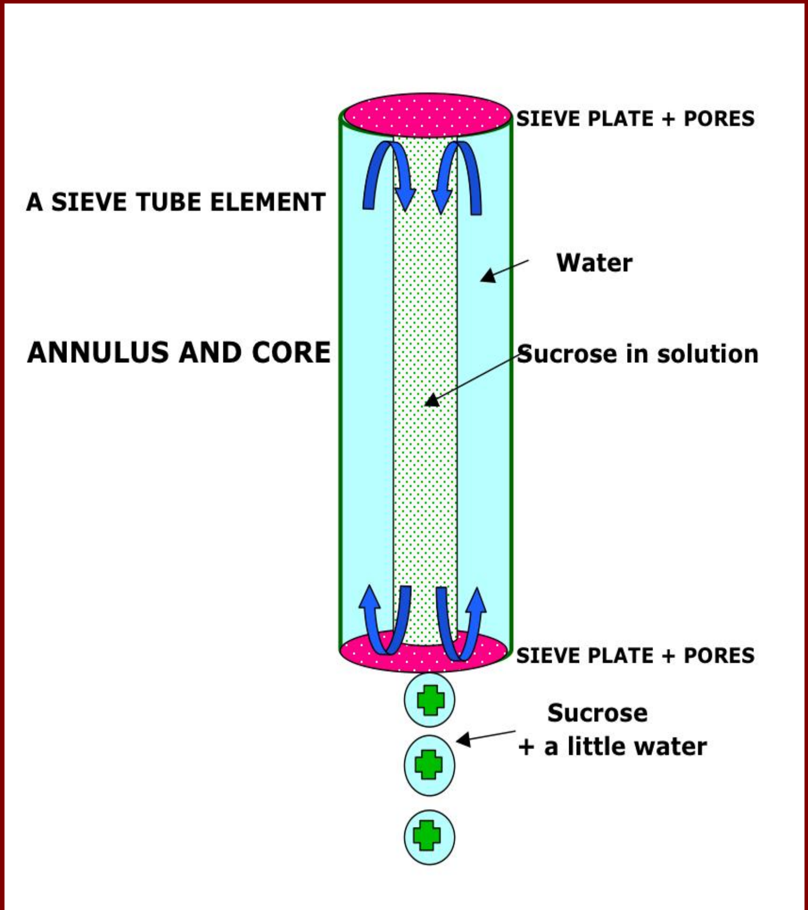


Image credit: fanpop.com

CONCLUSIONS

Partially-ionised liquids share some behaviour with ionised gas plasma

Radial charge distributions are significant

Electrical forces may be an important factor in the metabolism of plants

Plasma has come back to Life !