



universidad de buenos aires - exactas  
departamento de física  
Juan José Giambiagi

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**Dinámica de plasmas: de las descargas eléctricas a los dínamos estelares**

**DEPARTAMENTO DE FÍSICA FCEN  
INSTITUTO DE FÍSICA DEL PLASMA  
UBA-CONICET**

**DÍA DEL DEPARTAMENTO DE FÍSICA-J.J.GIAMBIAGI**



# Colaboradores



## Investigadores

- Dra. Diana Grondona
- Dr. Leandro Giuliani
- Dra. Laura Sraibman

## Estudiantes de doctorado

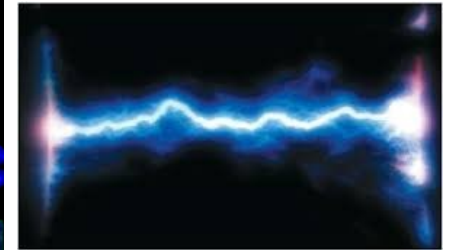
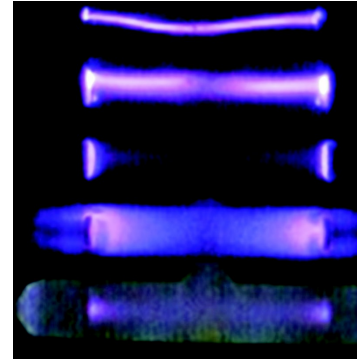
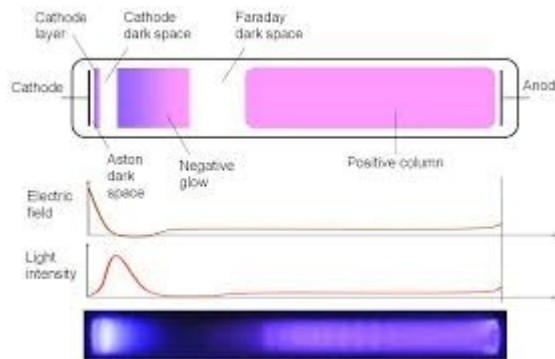
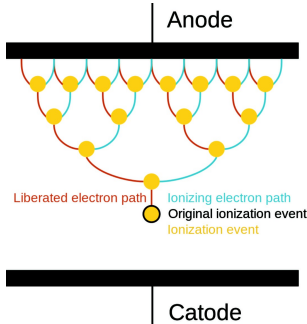
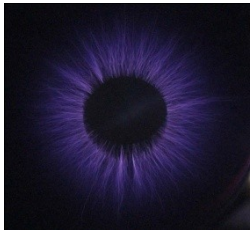
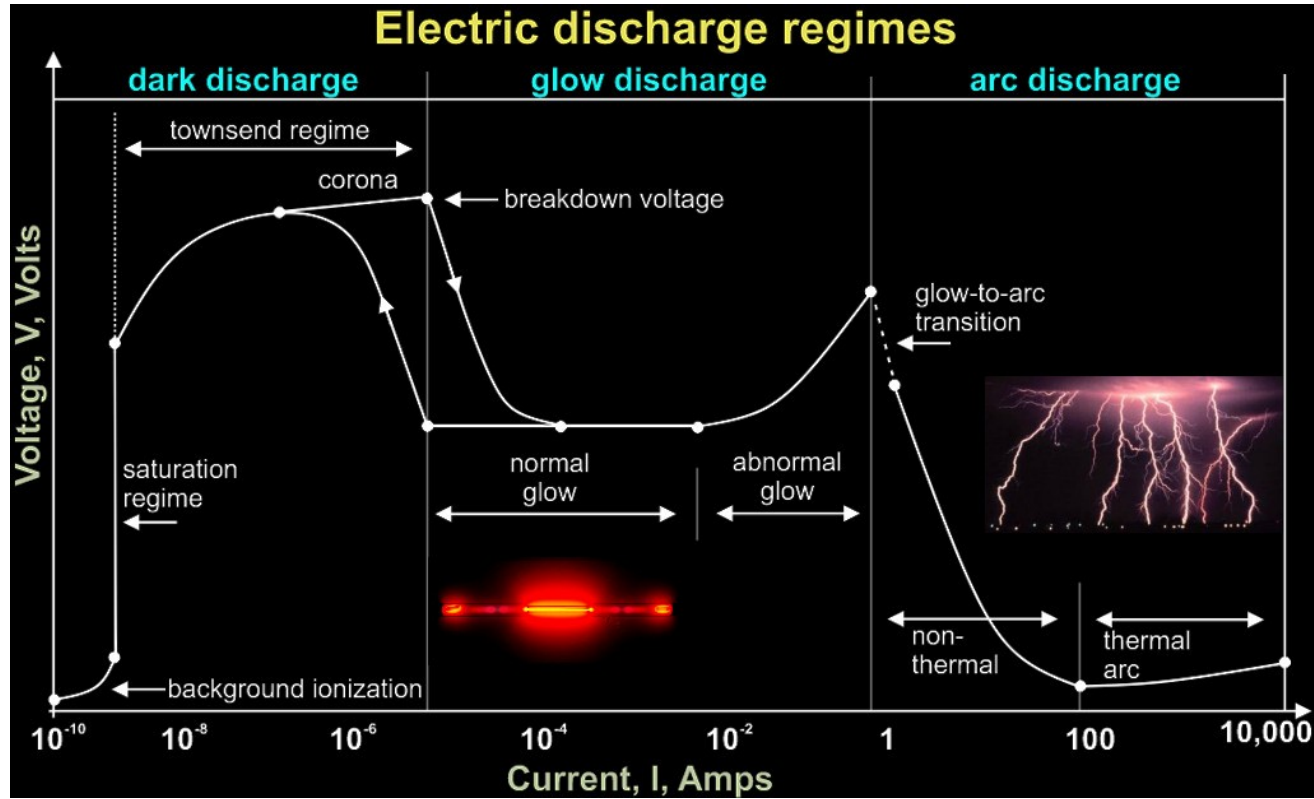
- Ing. Jorge Gallego
- Lic. Magalí Xaubet

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- L. Giuliani, M. Xaubet, D. Grondona, F. Minotti, and H. Kelly, *Phys Plasmas*, vol. 20, 063505 (2013).
- F. Minotti, L. Giuliani, D. Grondona, H. Della Torre and H. Kelly, *J. Appl. Phys.*, vol. 113, 113303 (2013).
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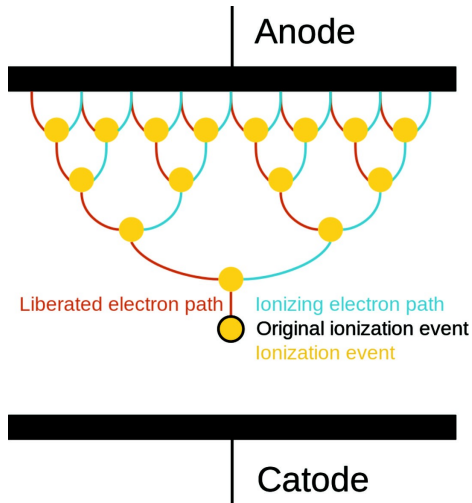
# Descargas eléctricas DC

## Electric discharge regimes

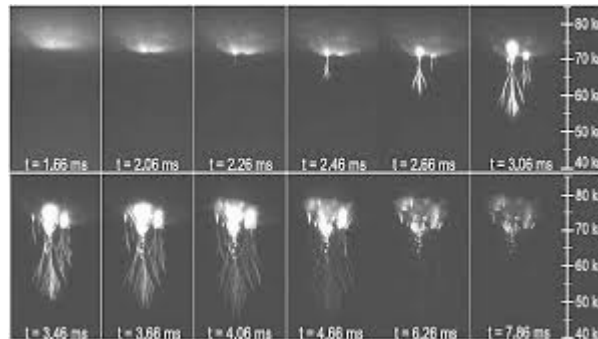
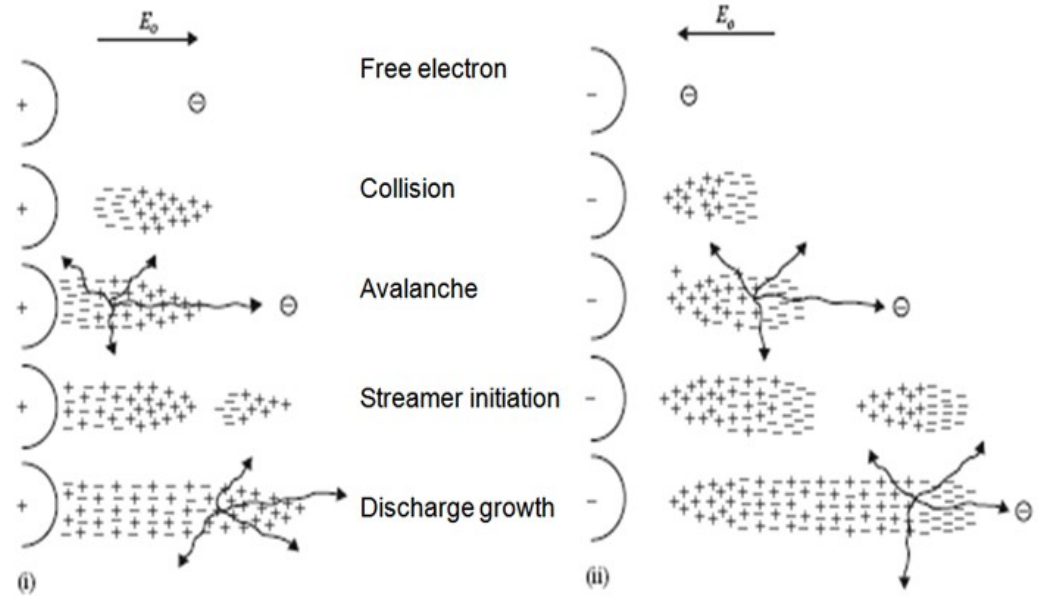


# Mecanismos de inicio ...

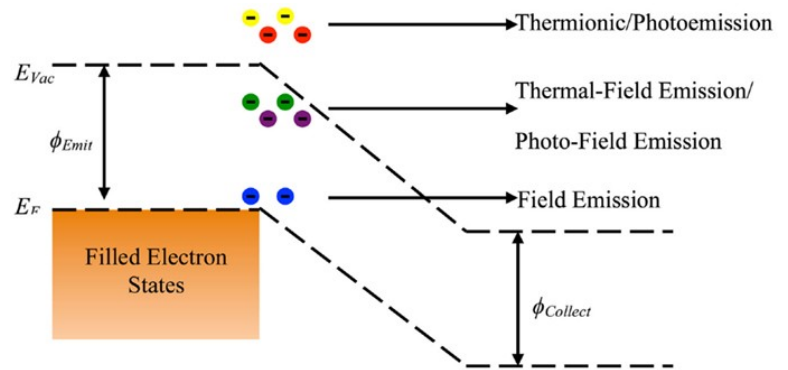
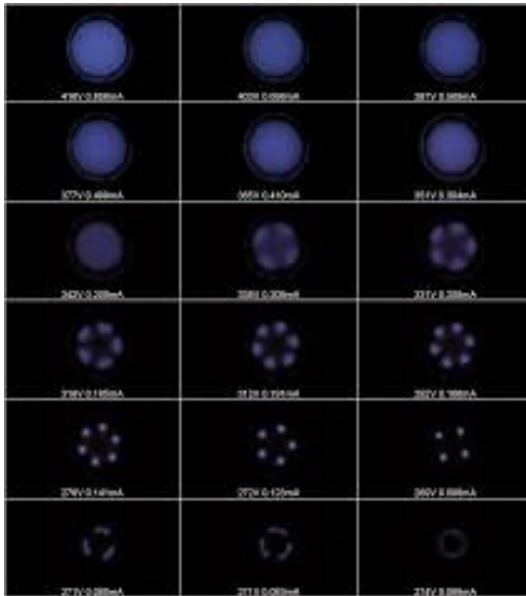
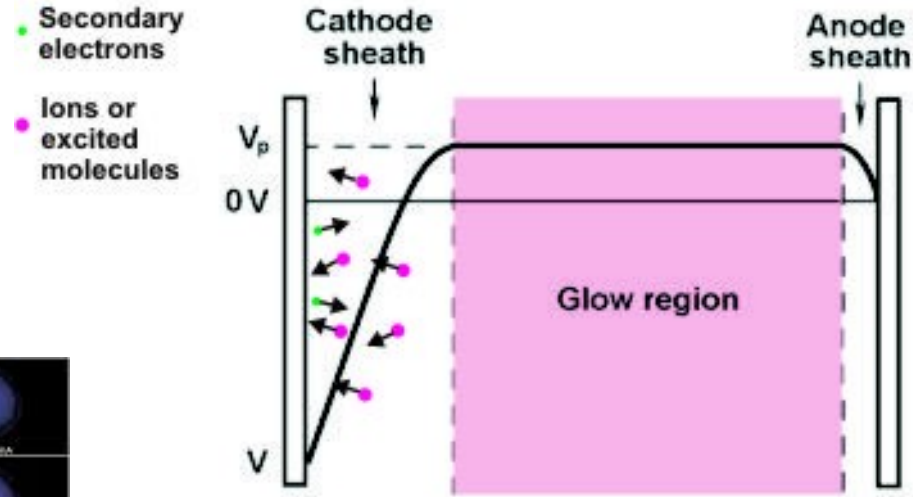
## Townsend



## Streamers

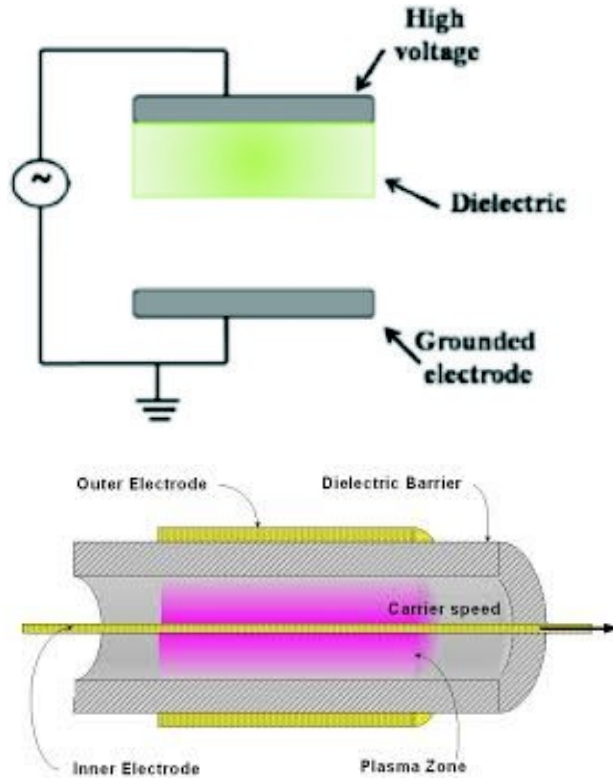


## ... y de sostenimiento

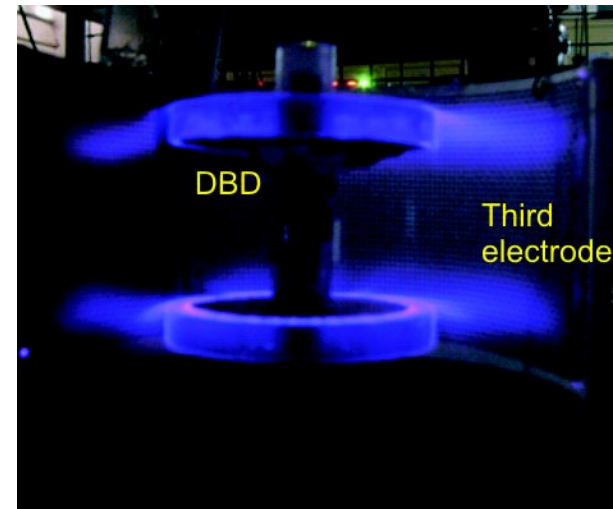
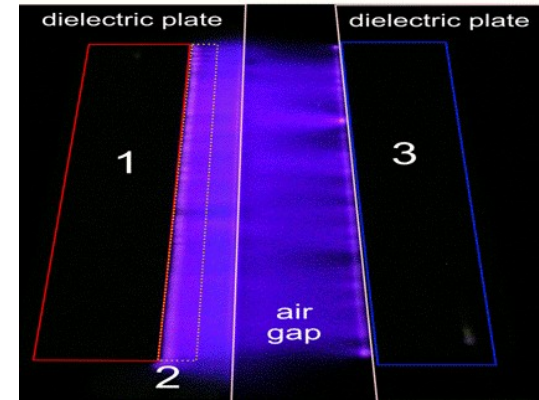


# Descargas eléctricas AC

## Barrera dieléctrica (DBD)

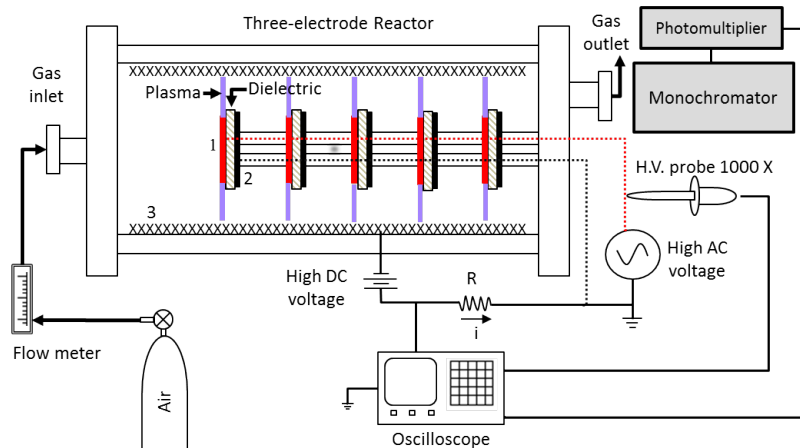
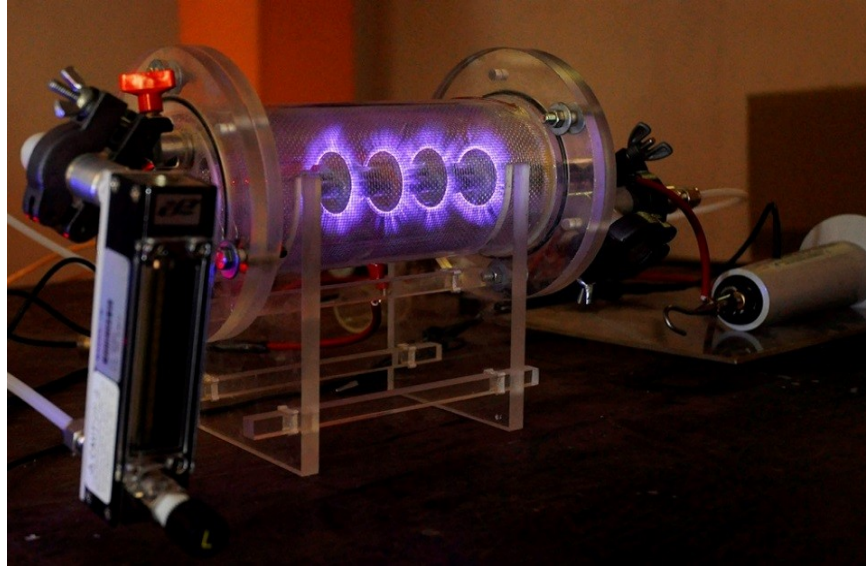


## Trielectrónica (plasma curtain)

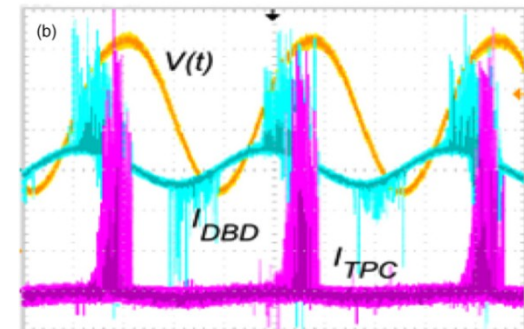
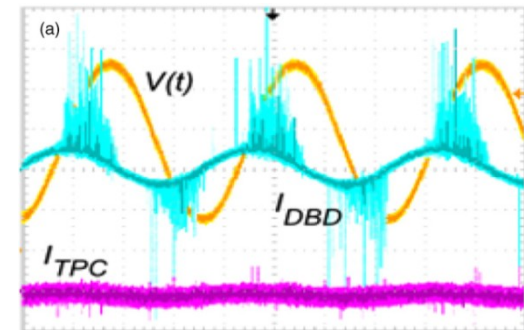
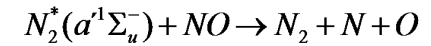
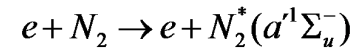
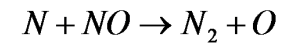
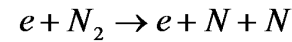




# Reactor para descontaminación de gases

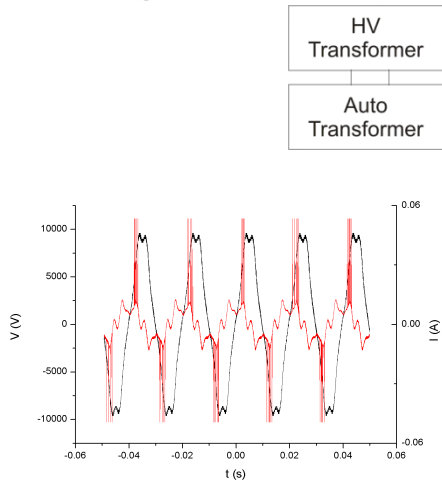


## Modelo de eficiencia de remoción de NO en ambiente de N<sub>2</sub>

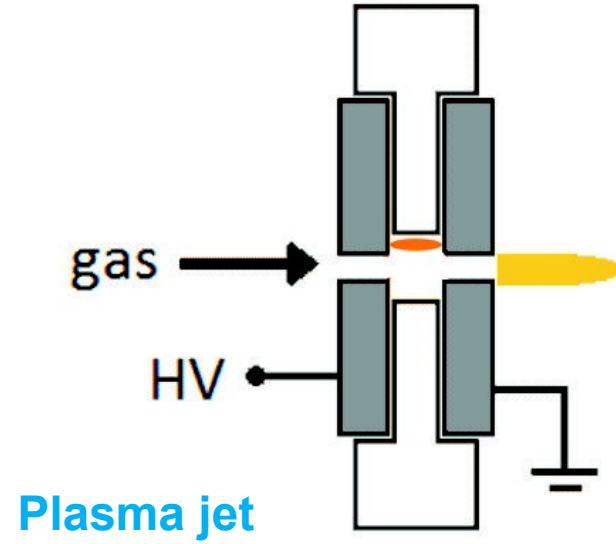
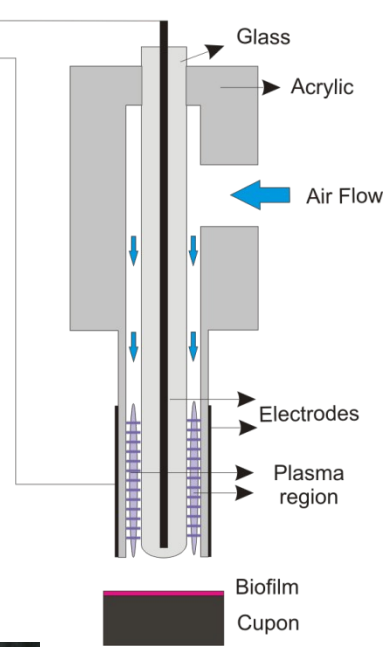




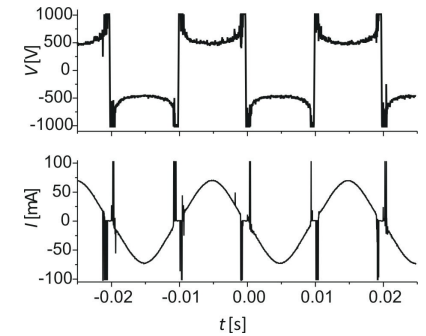
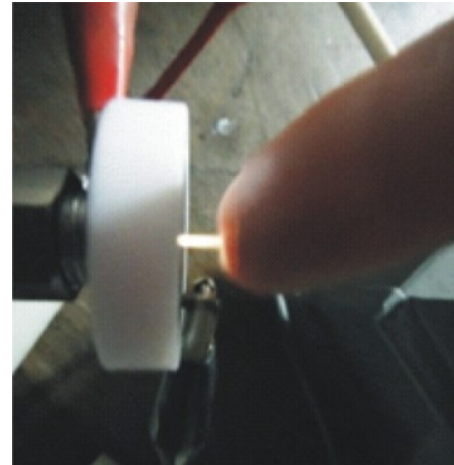
# Aplicaciones bio-médicas



DBD coaxial



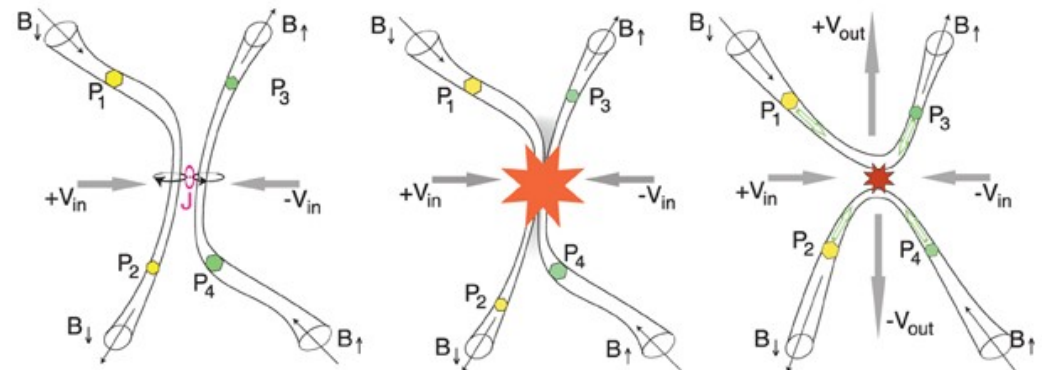
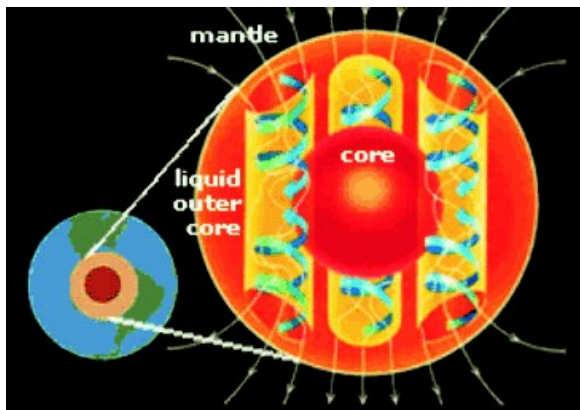
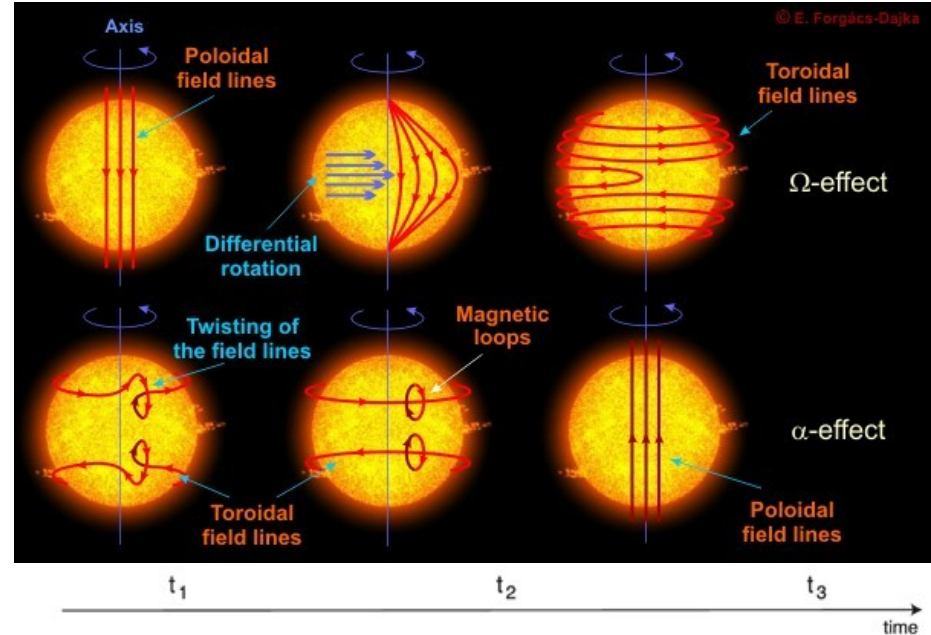
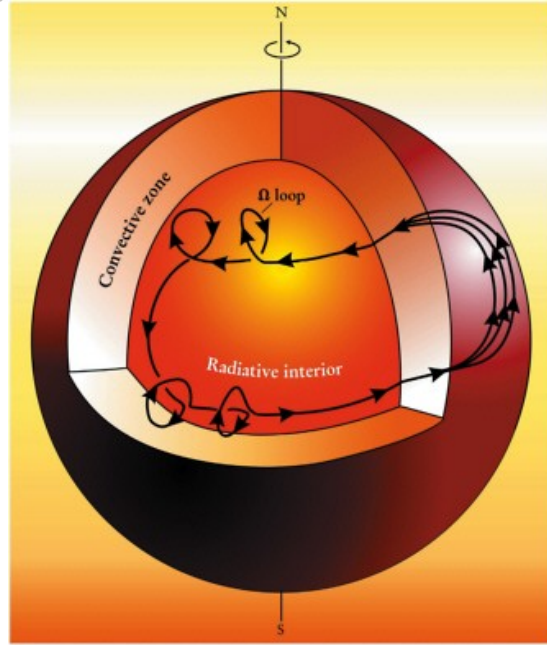
Plasma jet





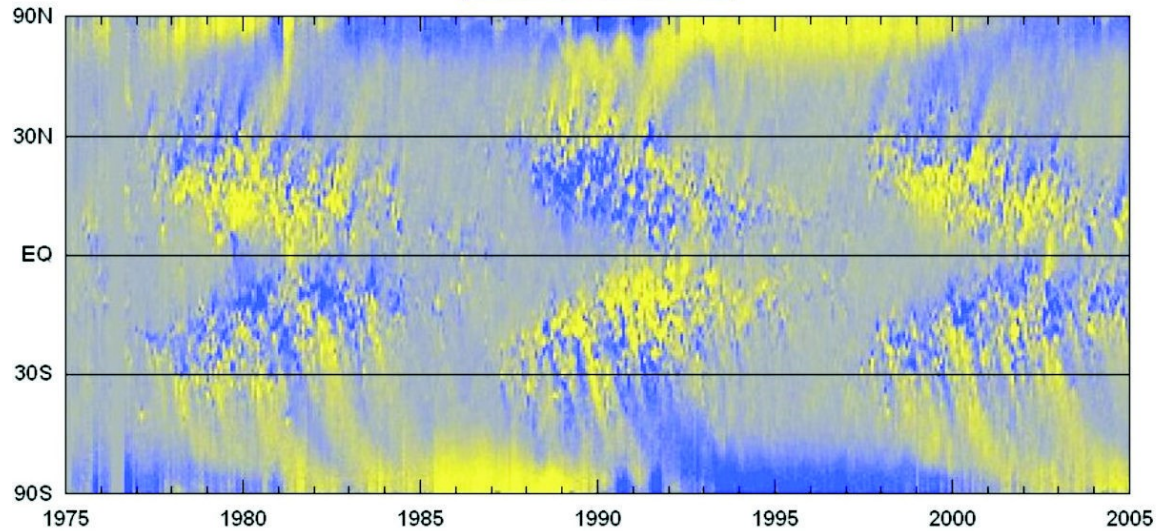
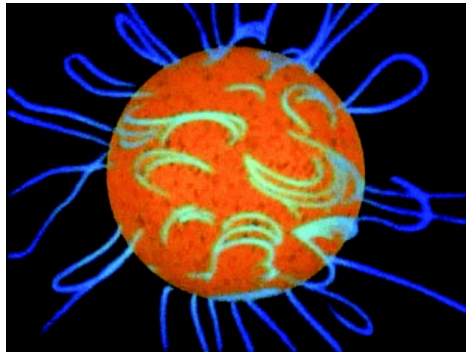
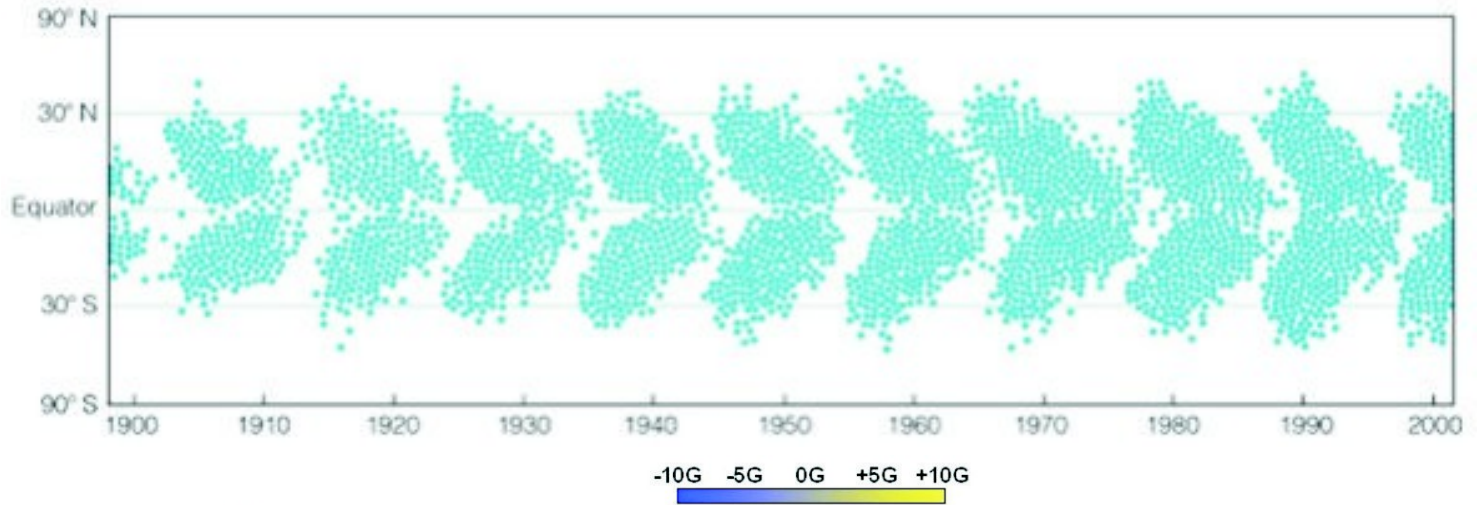
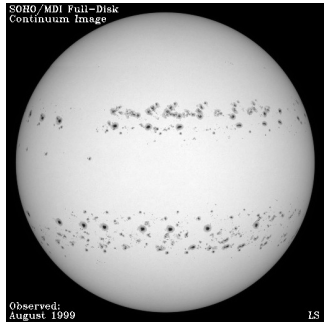


# Dínamos astrofísicos





# Observaciones: manchas solares y Br





## Modelo $\alpha$ - $\Omega$ de dínamo cinemático ( $u$ dada)

### Ecuación fundamental de evolución de $B$

$$\frac{\partial \mathbf{B}}{\partial t} = \nabla \times (\mathbf{u} \times \mathbf{B} - \eta \nabla \times \mathbf{B})$$

Responsable de arrastre  
transversal de líneas de  $B$

Responsable de reconexión  
de líneas de  $B$

### Ecuación de campo medio con modelo de turbulencia de pequeña escala

$$\frac{\partial \bar{\mathbf{B}}}{\partial t} = \nabla \times \left( \bar{\mathbf{u}} \times \bar{\mathbf{B}} + \alpha \circ \bar{\mathbf{B}} - \sqrt{\eta_T} \nabla \times (\sqrt{\eta_T} \bar{\mathbf{B}}) \right)$$

Incluye efecto  $\Omega$

Efecto  $\alpha$

Difusividad turbulenta



# Ecuación de grandes escalas

$$C(X, t) = \langle c(x, t) \rangle_X = \frac{1}{\Delta V} \int c(x, t) dV,$$

Promedio espacial centrado en  $X$   
en volumen de escala espacial  $\lambda$

$$\delta c(X, x, t) = c(x, t) - C(X, t) \quad \text{Fluctuación alrededor de } X$$

Propiedades

$$\left\{ \begin{array}{l} \langle C(X) \rangle_X = C(X), \quad \langle \delta c(X, x, t) C(X) \rangle_X = 0, \\ \left\langle \frac{\partial c}{\partial x} \right\rangle_X = \frac{\partial C}{\partial X} \end{array} \right.$$

$$\frac{\partial b}{\partial t} = \nabla \times (u \times b - \eta \nabla \times b)$$

Ecuación de evolución  
del campo magnético  $b$

$$\frac{\partial B}{\partial t} = \nabla \times (U \times B - \eta \nabla \times B) + \nabla \times S$$

$$S(X) = \langle \delta u(X, x) \times \delta b(X, x) \rangle_X$$

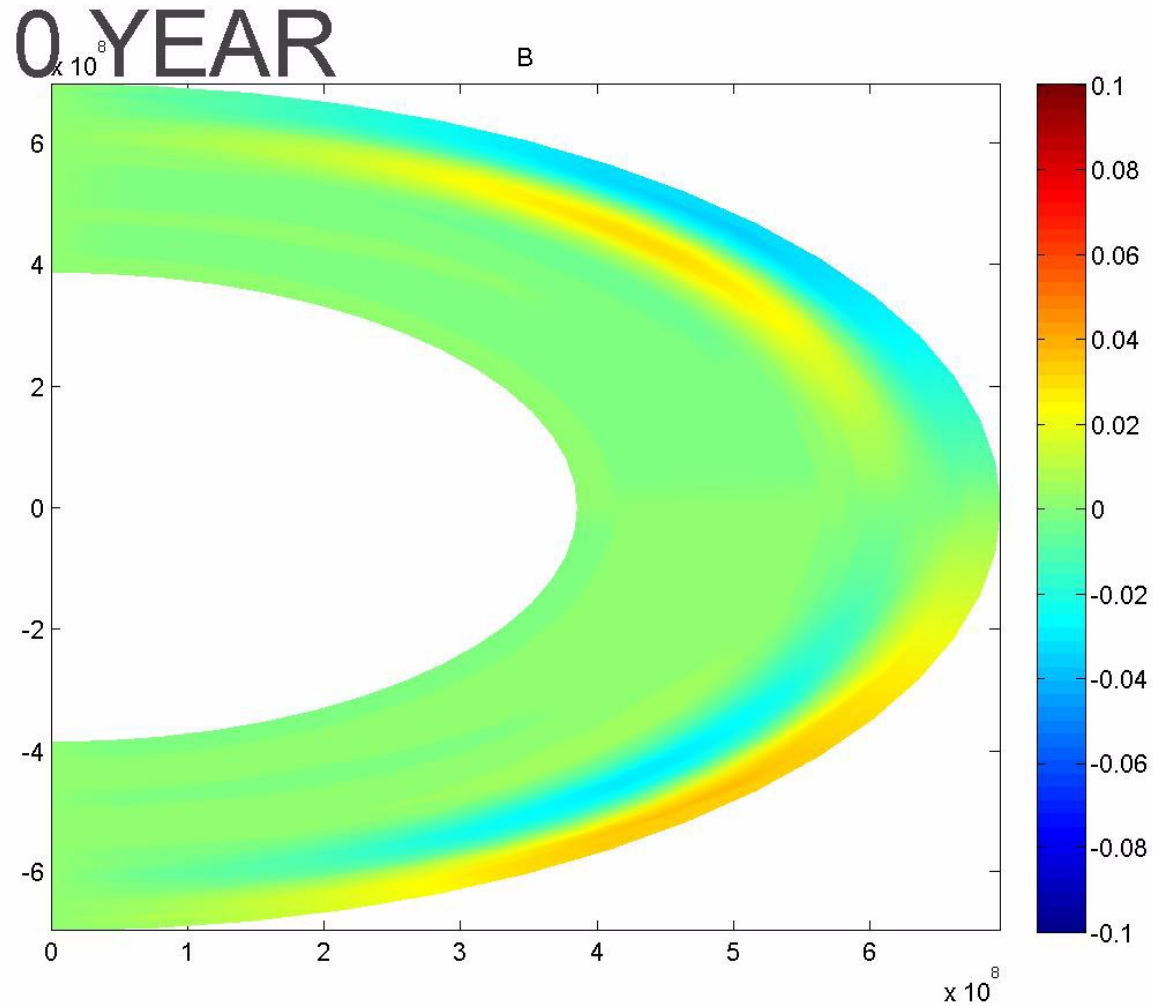
Formalismo [Minotti (2000)] permite deducir:

$$S = \frac{\lambda^2}{48} [\nabla^2 (U \times B) - (\nabla^2 U) \times B - U \times \nabla^2 B]$$





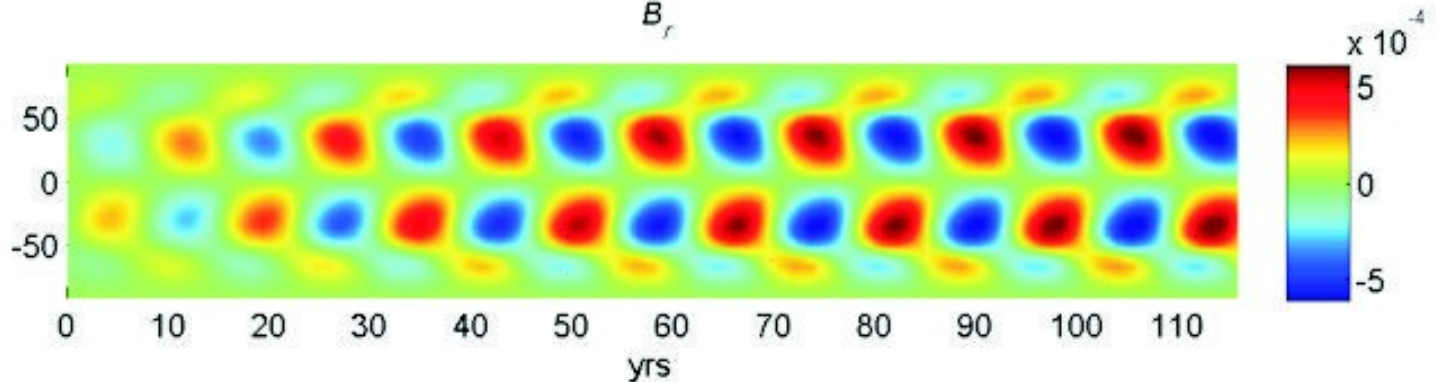
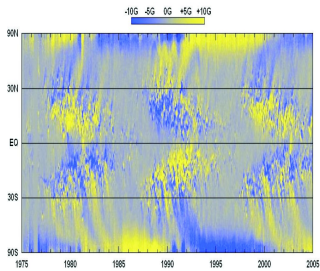
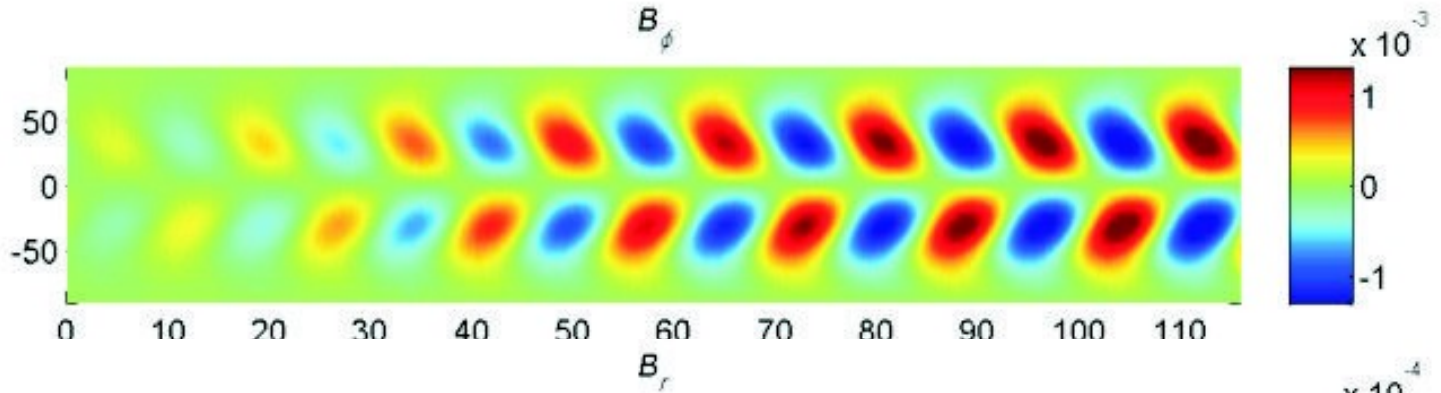
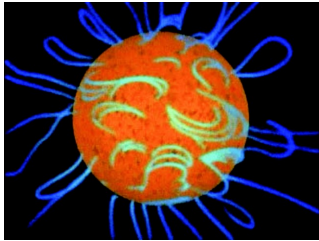
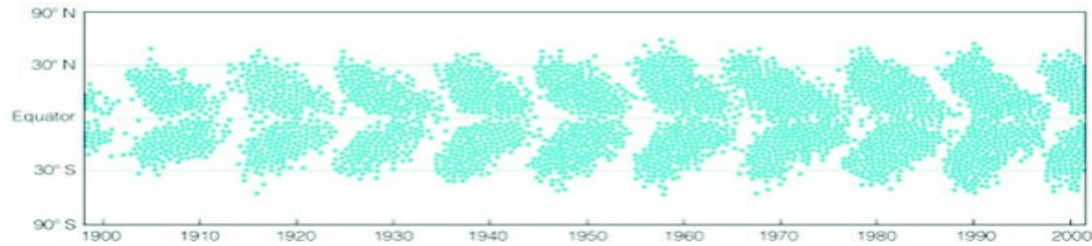
## Simulación caso solar: campo toroidal







# Simulación caso solar: diagramas mariposa, $B_r$ y $B_\phi$





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**Muchas gracias!!**



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