

# CORRIENTES ESTELARES

## Aquellos ríos de estrellas en la Galaxia y el Universo local

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La Charla de los Viernes en el Planetario UNLP

# El grupo DOTS



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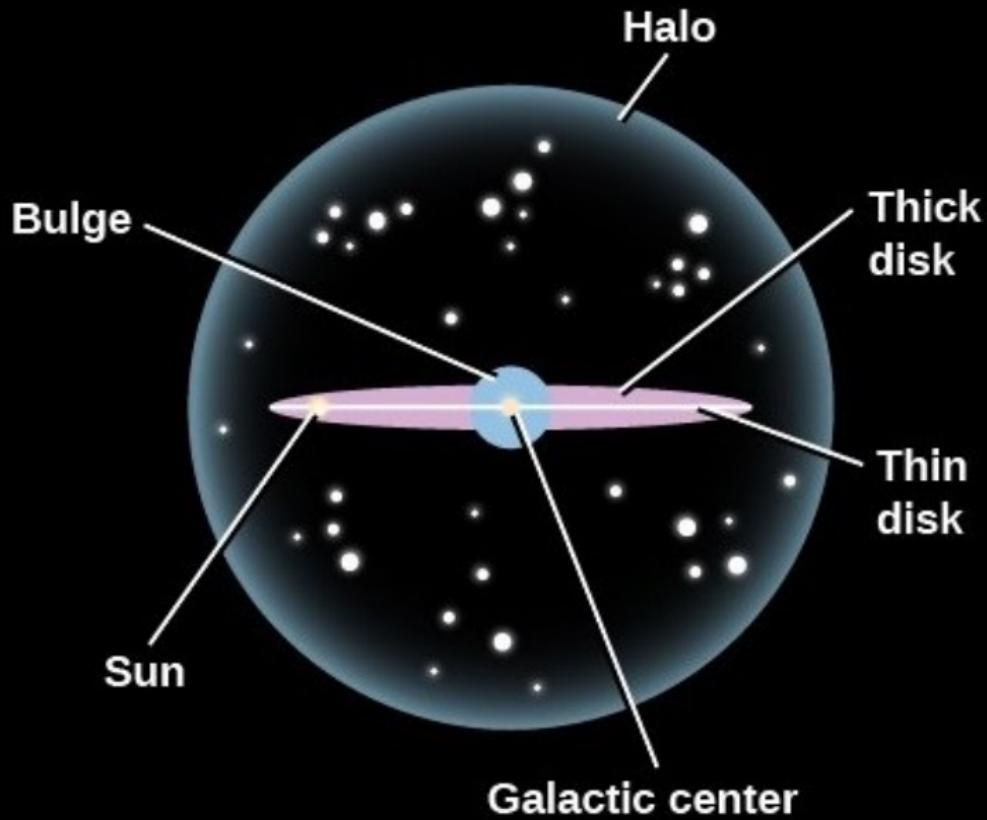
Martín Mestre

# Una galaxia de disco típica

Messier 81 (HST)



# Modelo simplificado de la Galaxia



# Se empiezan a encontrar subestructuras: Arcturus stream

276

O. J. EGGEN

1971PASP...83..271E

stars in the other old disk population groups (cf. Eggen 1971c), the period is probably 80 to 90 days.

### III. Kinematics

If we adopt  $(U', V')_0$  with respect to the local standard of rest, of  $(+10, -16)$  km/sec (Eggen 1970a), the Arcturus group has  $V' = -100$  km/sec with respect to that standard. The parameters of the orbits of the group stars, based on the galactic potential field discussed by Eggen, Lynden-Bell, and Sandage (1962) are listed in Table III. The group stars,  $U'$  between  $-20$  and  $-60$  km/sec, are now at apogalactium,  $R_{\max}$  between 10.1 and 10.4 kpc, in orbits with  $e = (R_{\max} - R_{\min})/(R_{\max} + R_{\min}) = 0.45$ .

TABLE III  
ORBITAL PARAMETERS FOR STARS WITH  
 $V' = -100$  KM/SEC AND THE LISTED VALUES OF  $U'$

$U'$ (km/sec)	$R(\text{Max})$ Kpc	$R(\text{Min})$	$e$
+ 40	10.10	3.87	0.445
+ 20	10.08	3.90	0.44
± 0	10.08	3.90	0.44
- 20	10.08	3.90	0.44
- 40	10.10	3.87	0.445
- 60	10.40	3.84	0.46
- 80	10.90	3.80	0.485
-100	11.10	3.73	0.495

The values of  $U$  and  $Y$  for the members of the

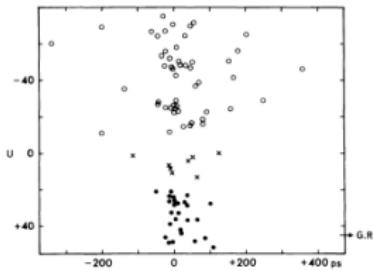
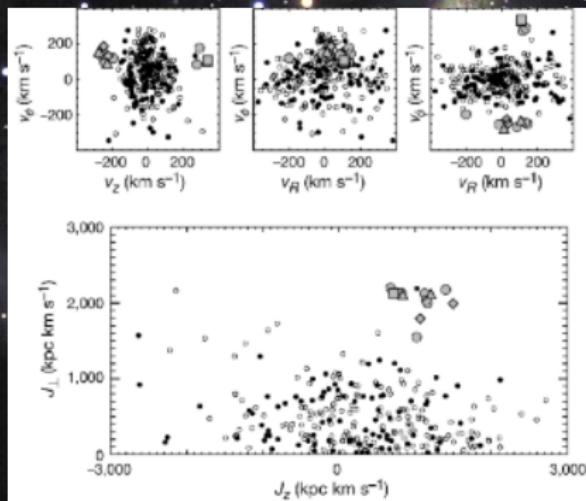


FIG. 5.—The correlation between the  $U$  vectors of the space motion and  $Y$ , the distance from the sun in the direction of galactic rotation, for members of the Arcturus group in Table I (open circles). Stars in Table IV are shown as crosses and the filled circles are members of the  $\eta$  Cephei group.

The  $\eta$  Cephei group members (Eggen 1971b) have values of  $U$  between  $+20$  and  $+50$  km/sec and  $V(-97 \text{ km/sec})$  is only about 10 percent less than that for the Arcturus group stars. The  $U$  vectors of  $\eta$  Cephei group members are shown as filled circles in Figure 5. The trigonometric parallax of Arcturus is too well established to allow a change from  $-119$  to  $-97$  km/sec and the value of  $V = -97$  km/sec for  $\eta$  Cep is based on a trigonometric parallax of  $0''.071$  (weight 52) whereas  $V = -116$  km/sec would require a value of  $0''.027$ . Although the difference in the  $V$  velocity of the two groups is small, it

# Helmi stream

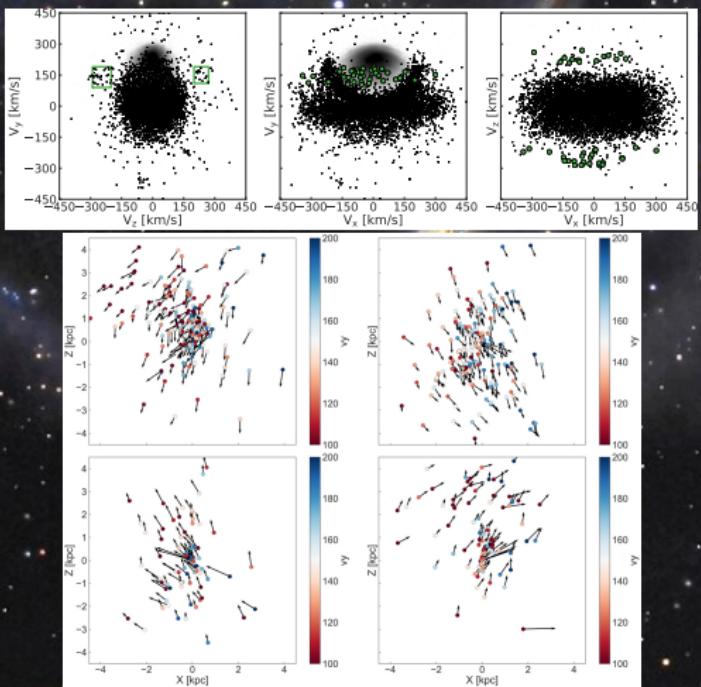
• Satélite Hipparcos  
Miembros detectados: 13 estrellas



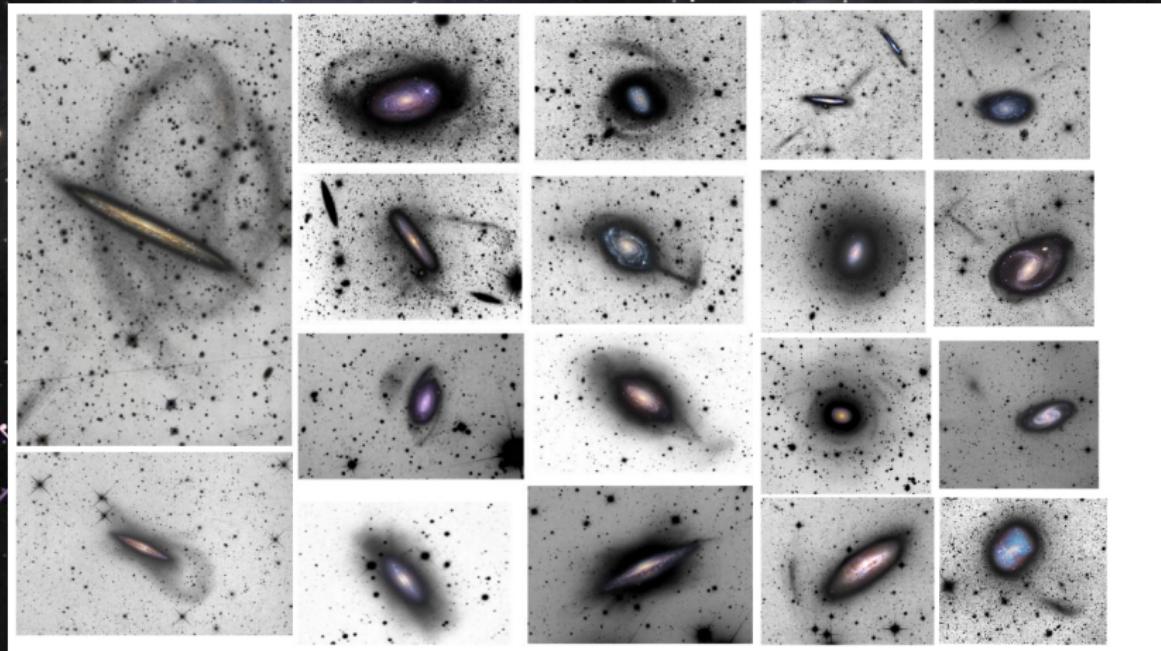
# Helmi stream

Satélite Gaia

Nuevos miembros detectados:  $\sim 600$  estrellas



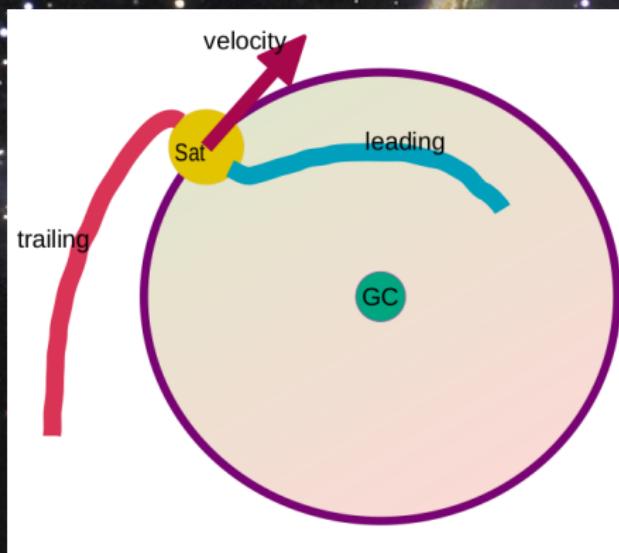
# Corriente estelares en el Universo local



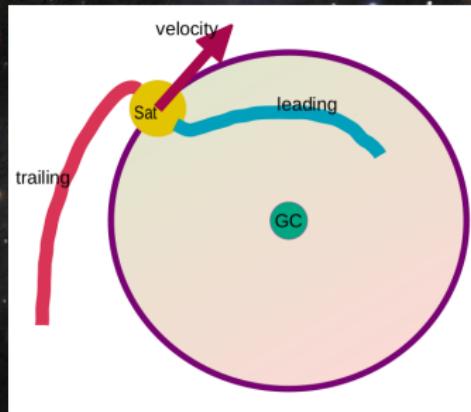
# Qué es una corriente estelar?

Es el sistema que se forma cuando un sistema auto-gravitante de estrellas (cúmulo globular o galaxia enana) es desarmada por las fuerzas gravitatorias de marea producidas por la galaxia anfitriona.

Generalmente un par de brazos de marea son formados, uno que va hacia adelante y otro hacia atrás del progenitor.

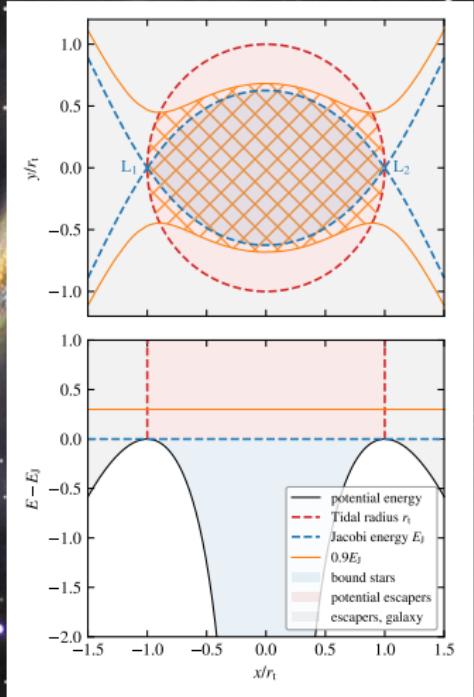


# El radio de marea



Para órbitas circulares en un potencial con simetría esférica:

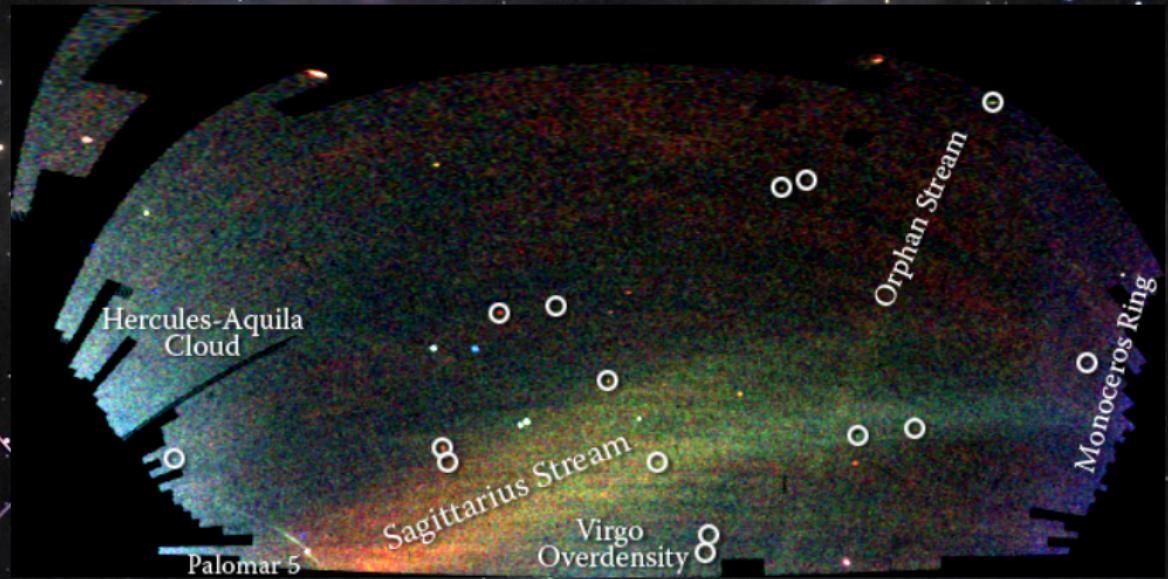
$$r_t \approx \left( \frac{Gm}{\Omega^2 - \frac{\partial^2 \Phi}{\partial R^2}} \right)^{1/3}$$



# Simulación de corriente estelar genérica

Animación: 1\_GlobularClusterStreamInMWwithSubHalos.mp4

# El campo de corrientes estelares

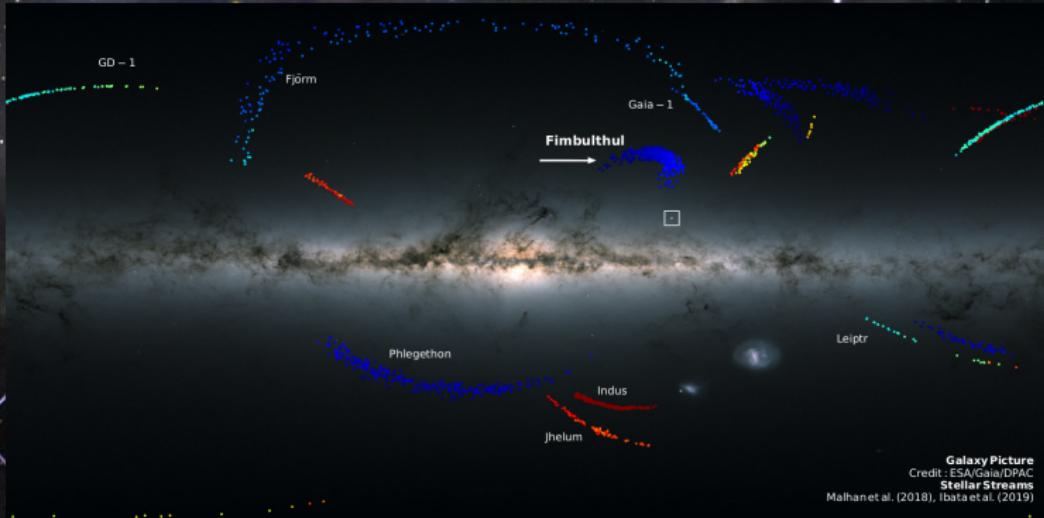


Blokurov V. et al. 2006

# Simulación de corriente estelar de Sagitario

Animación: 2\_FormationSagittariusStreamWithLMC.mp4

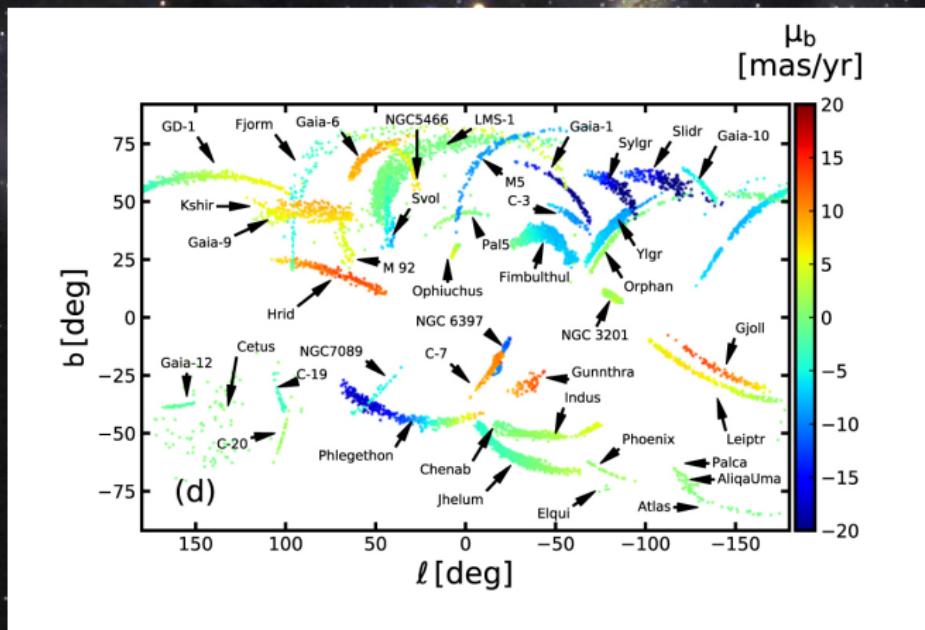
# La era de Gaia



# Corrientes estelares en la Galaxia

Atlas de las fusiones en la Vía Láctea (Malhan et al. 2022)

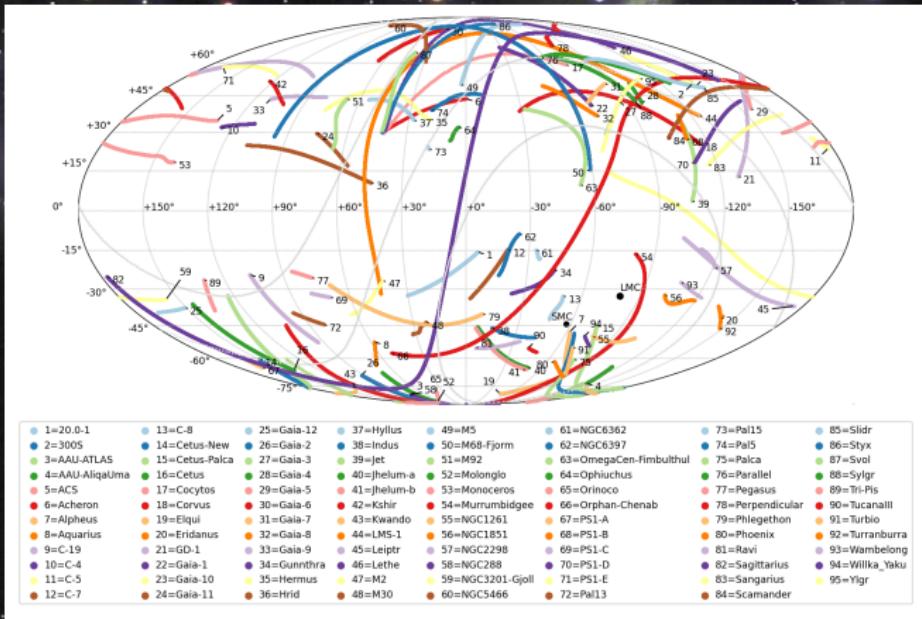
41 corrientes comprendiendo un total de 9192 estrellas de Gaia EDR3



# Corrientes estelares en la Galaxia

Código Galstreams en Python (Cecilia Mateu 2022)

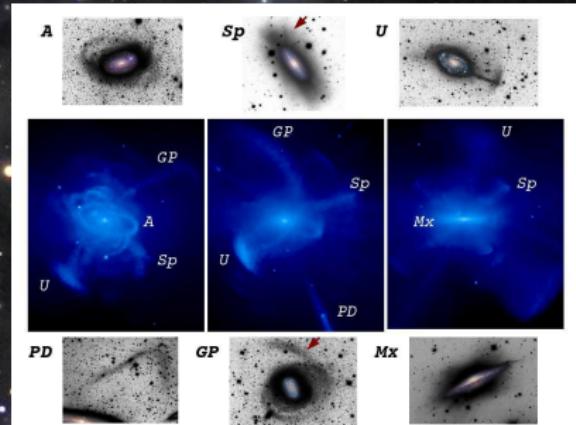
95 corrientes con trayectorias 5D/6D disponibles



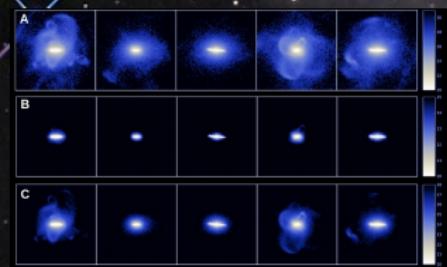
# Corrientes estelares en la computadora

Efectos de marea:

- Círculos máximos
- Plumas
- Caparazones
- Paraguas
- Nubes gigantes



Martínez-Delgado D. et al. 2010, Johnston et al. 2008

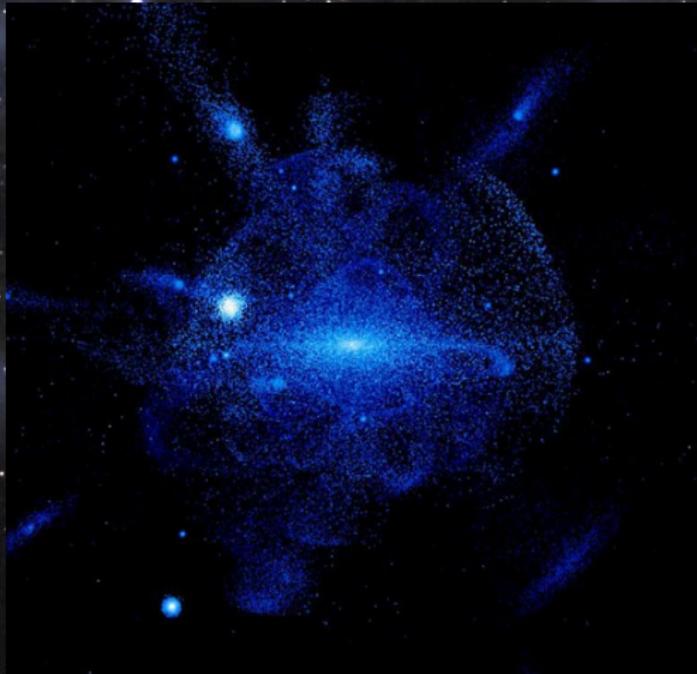


Martínez-Delgado D. 2018

Corrientes alrededor de galaxia tipo VL para diferentes valores del límite de brillo superficial detectable (mag/arcsec<sup>2</sup>):

- $\mu_A = 31$
- $\mu_B = 25$
- $\mu_C = 28$

# Corrientes simuladas en la computadora

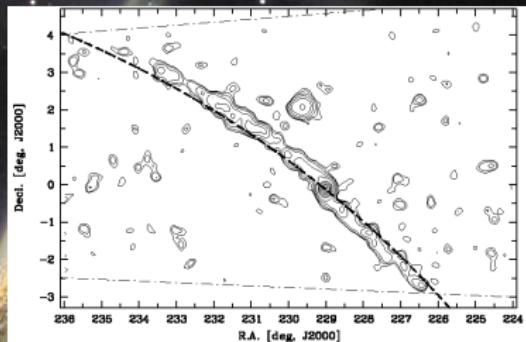
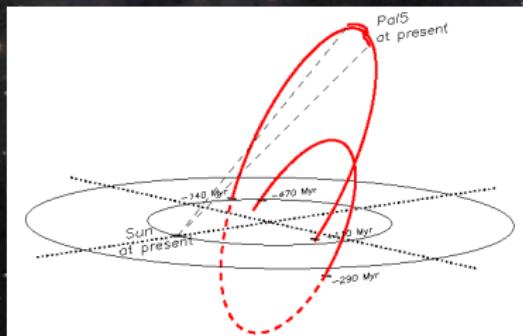


Consistente con un Universo jerárquico formado por sucesivas fusiones de galaxias

# Corriente Palomar 5

(Odenkirchen 2000+)

Una corriente estelar que transita por el halo y la barra



$$d_{CG} \approx 16 \text{ kpc}$$

$$d_\odot \approx 20 \text{ kpc}$$

$$\text{longitud} \approx 20^\circ / 7 \text{ kpc}$$

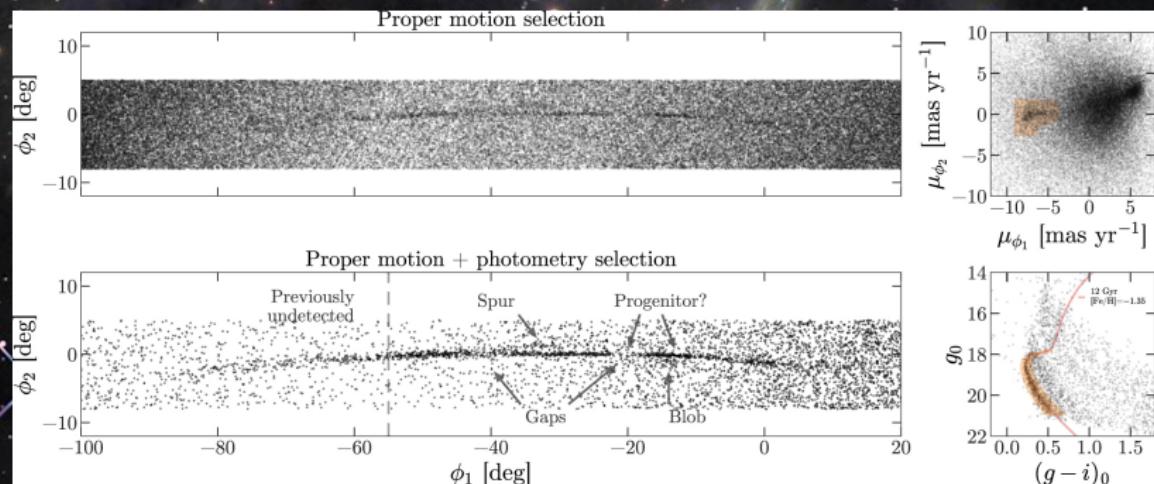
$$\text{ancho} \approx 120 \text{ pc}$$

# Corriente estelar GD-1

(Grillmair & Dionatos 2006)

Una corriente estelar "fría"

(Price-Whelan & Bonaca 2018)

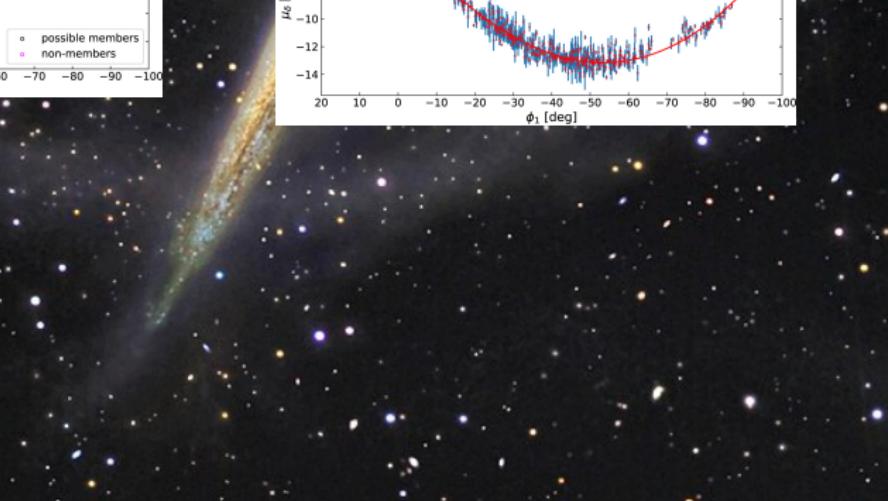
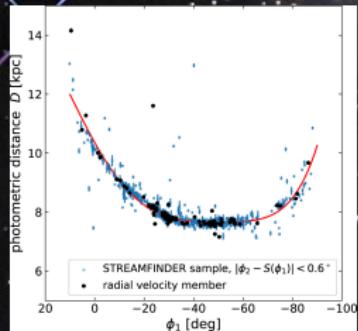
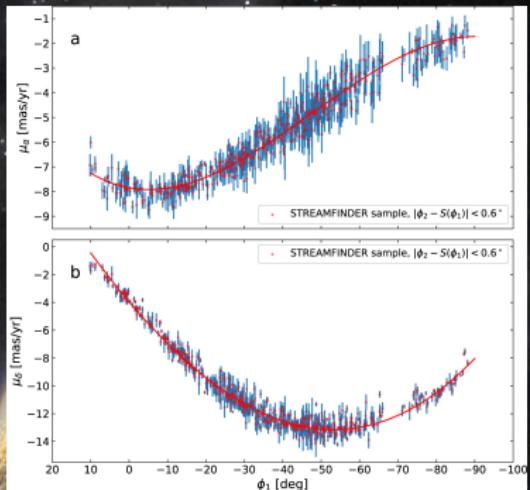
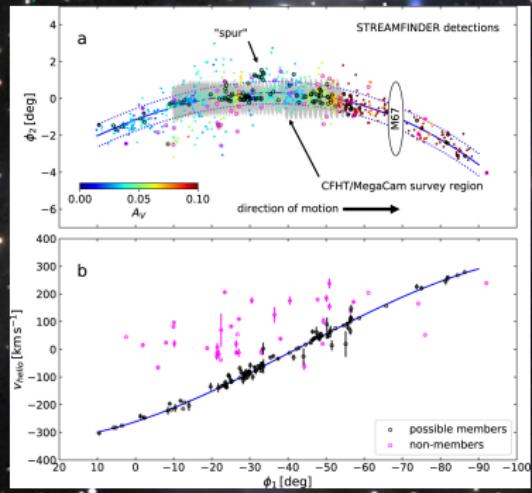


$d_\odot \approx 10 \text{ kpc}$   
length  $\approx 100^\circ / 10 \text{ kpc}$

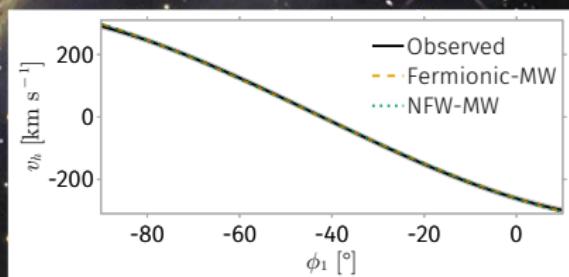
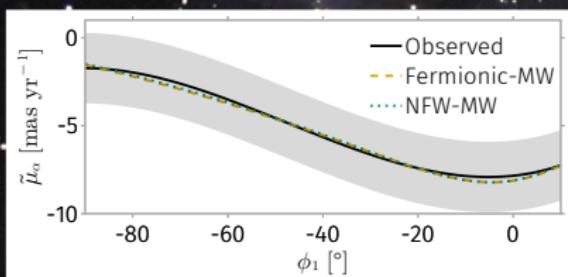
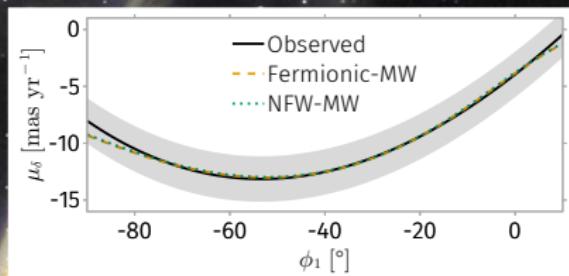
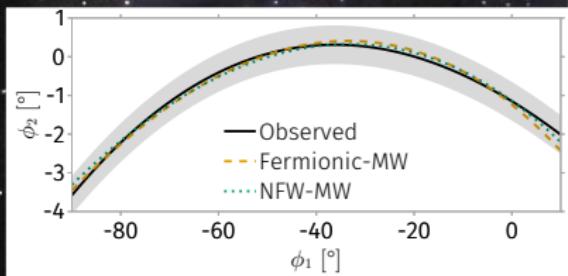
width  $\approx 12^\circ / 30 \text{ pc}$

# Observables de la corriente GD-1

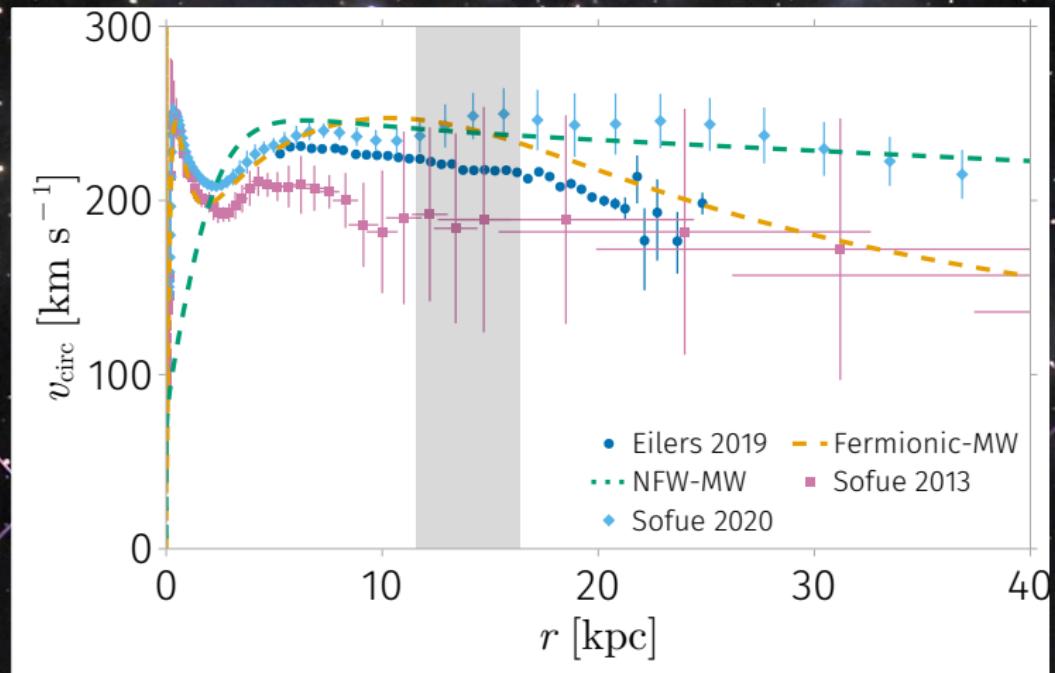
(Ibata+20)



# Resultado de ajuste de potencial gravitatorio



# Curva de rotación Galáctica



# 42 corriente estelares

Animación: 3\_42StellarStreams.mp4

# Atlas global de las fusiones en la VL

Animación: 4\_AtlasOfStreams.mp4

# Fusión de dos galaxias de disco

Animación 360°: GalaxyCollision

# ¡Muchas gracias!



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