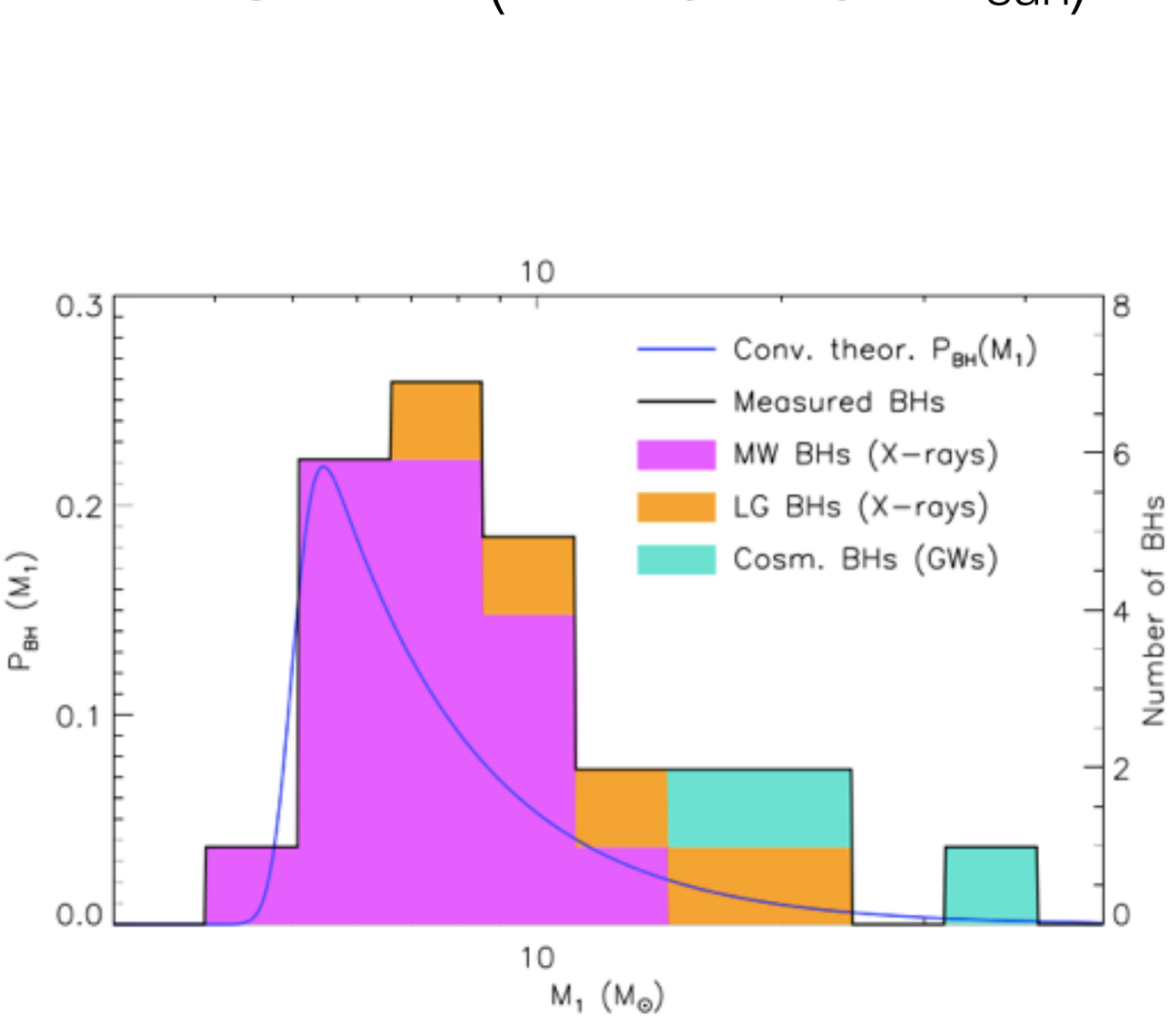
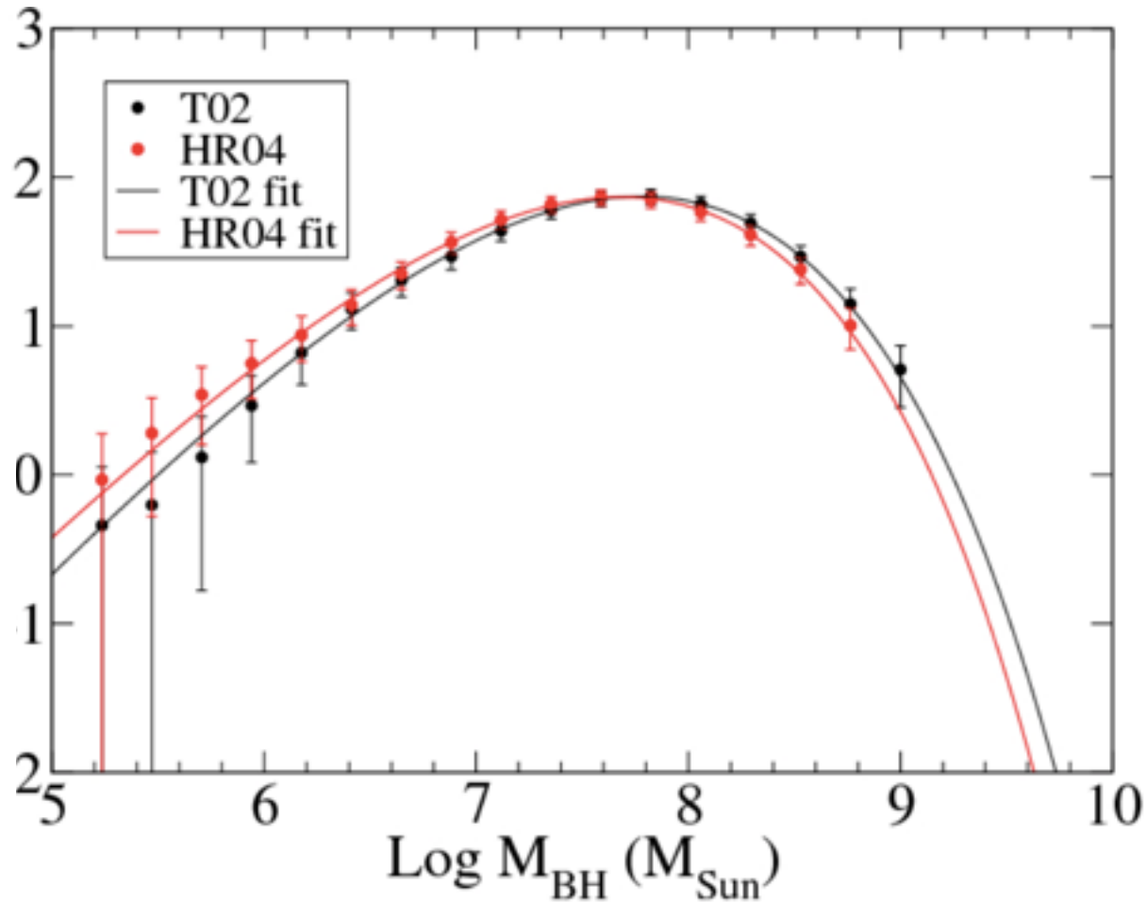
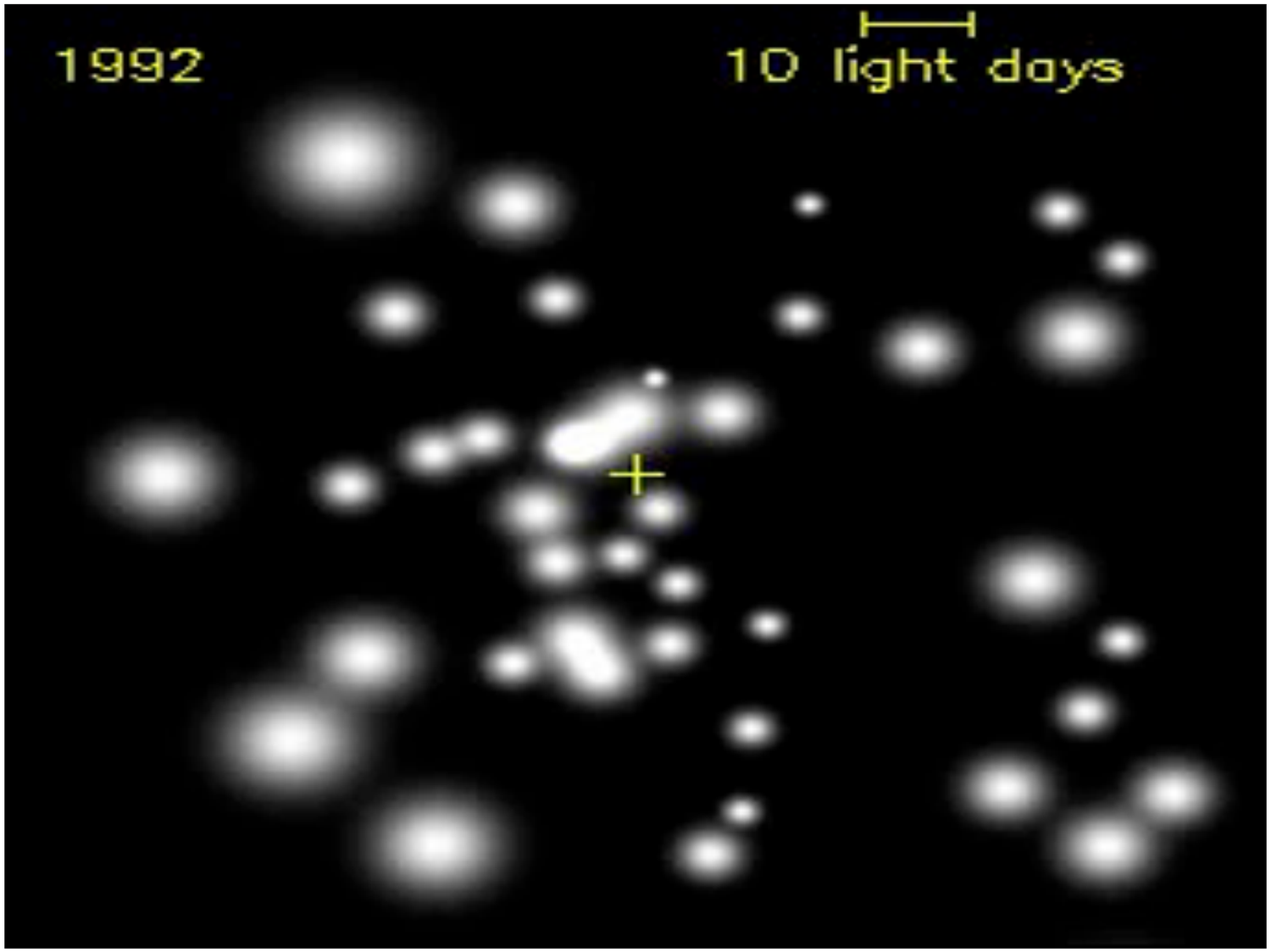
Distribuzione di massa dei buchi neri

- Due popolazioni:
  - Stellar mass BHs (M~10-30 M_{sun})
  - SMBH (M~10^5-10^9 M_{sun})

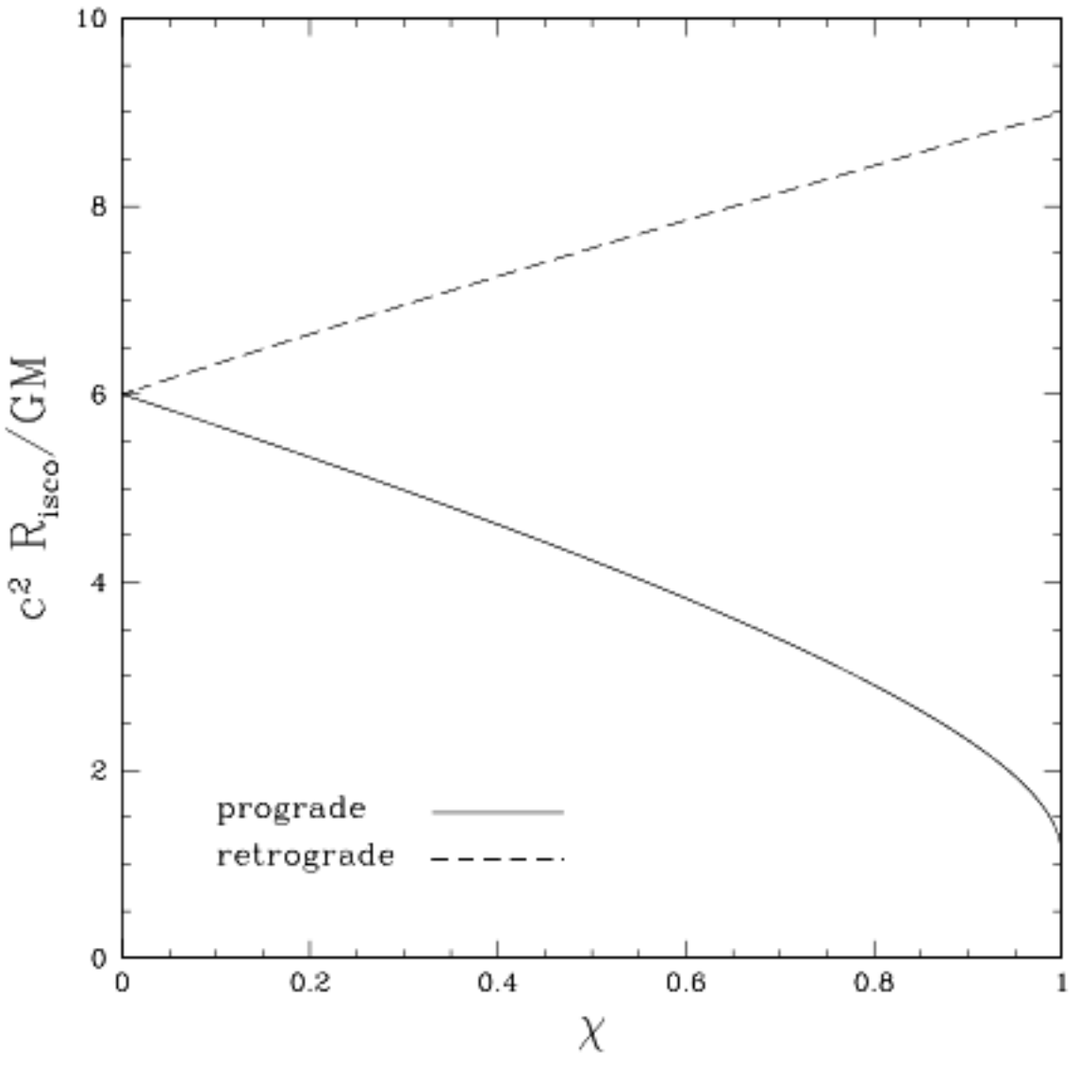


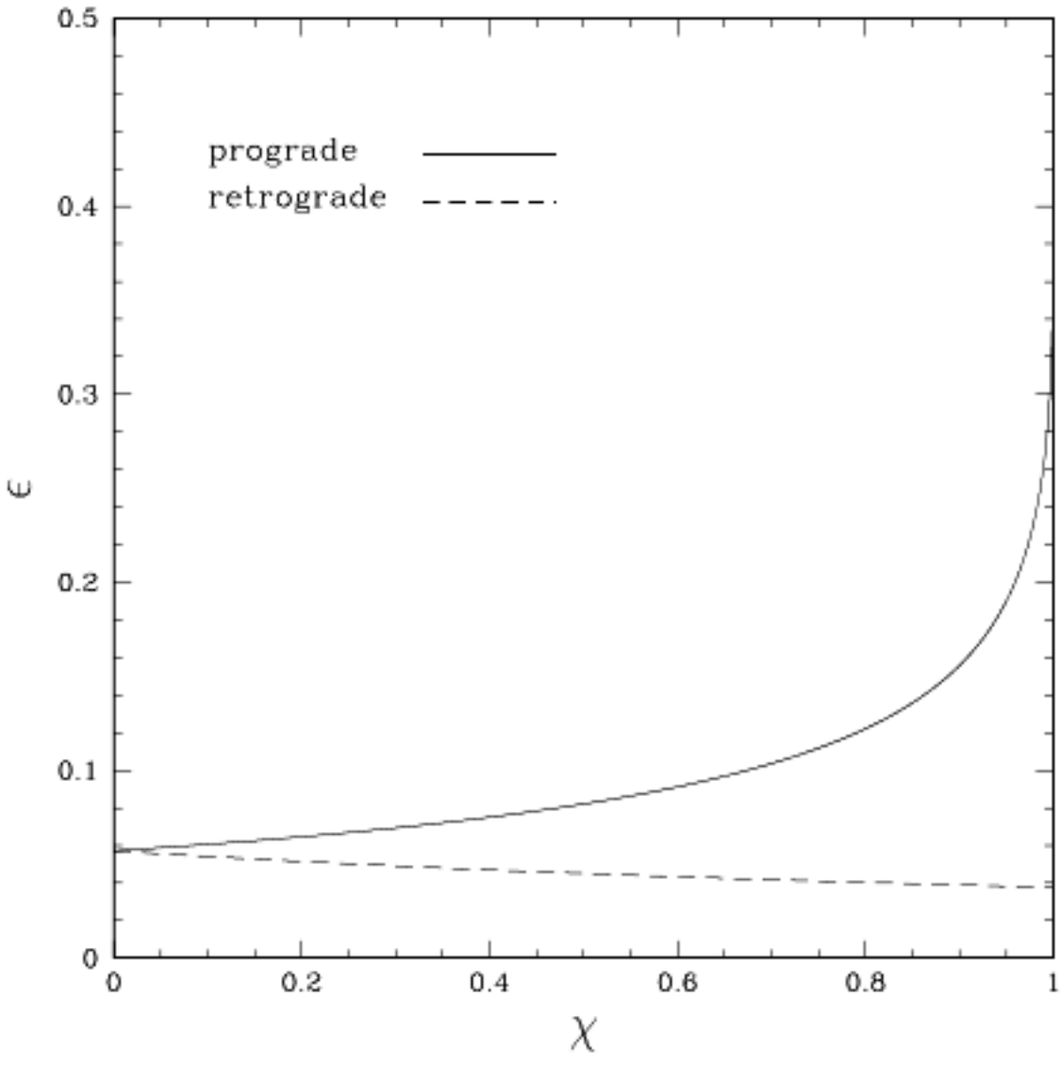


Il buco nero della nostra Galassia: Sgr A*

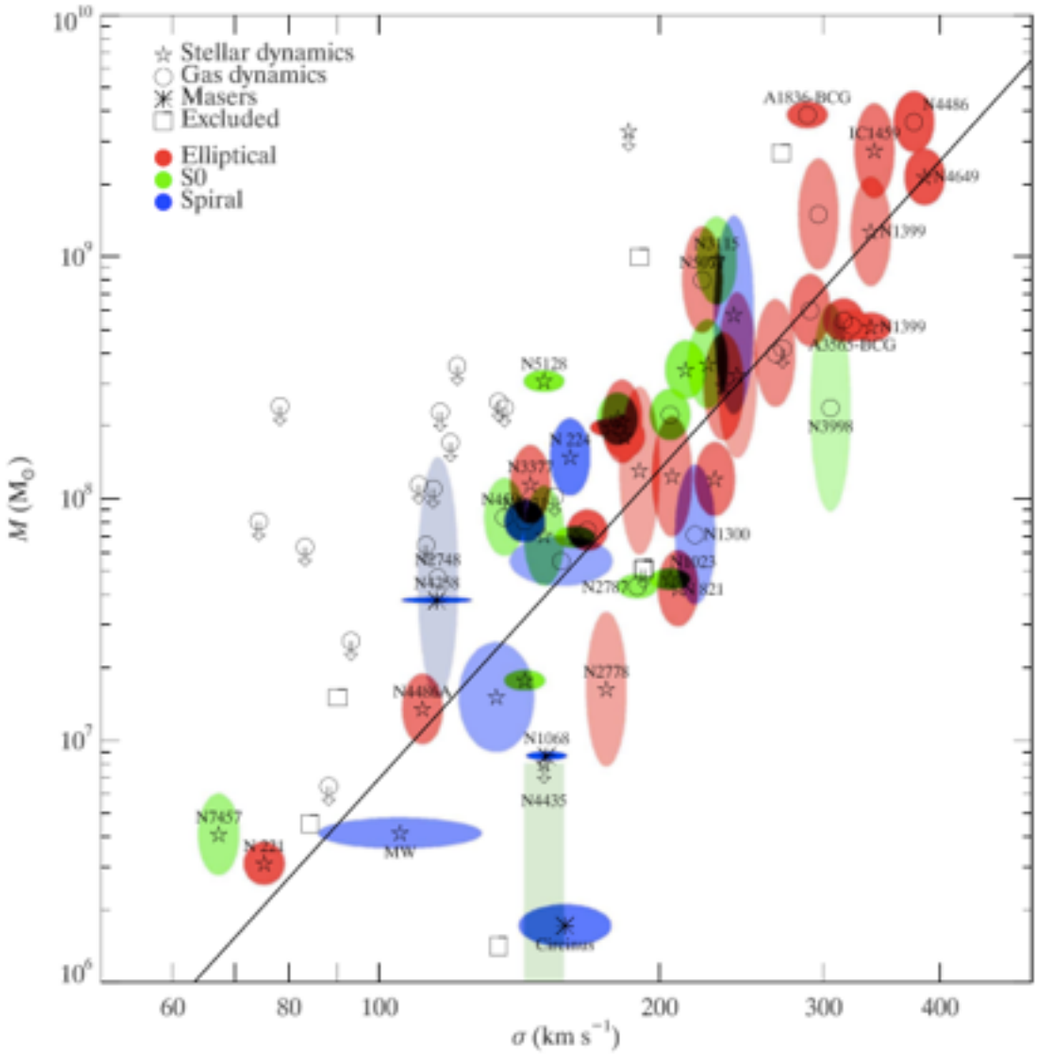


Efficienza dell'accrescimento

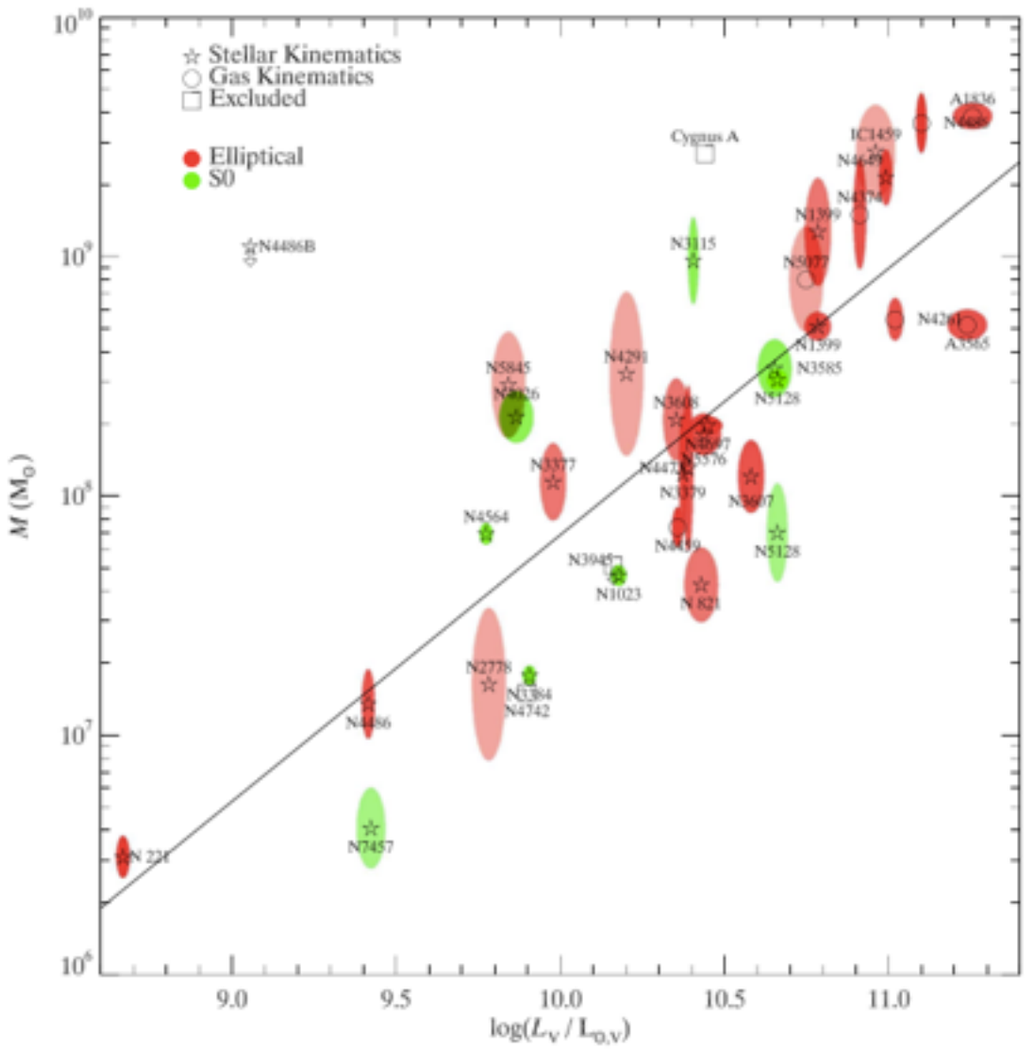




SMBH scaling relations



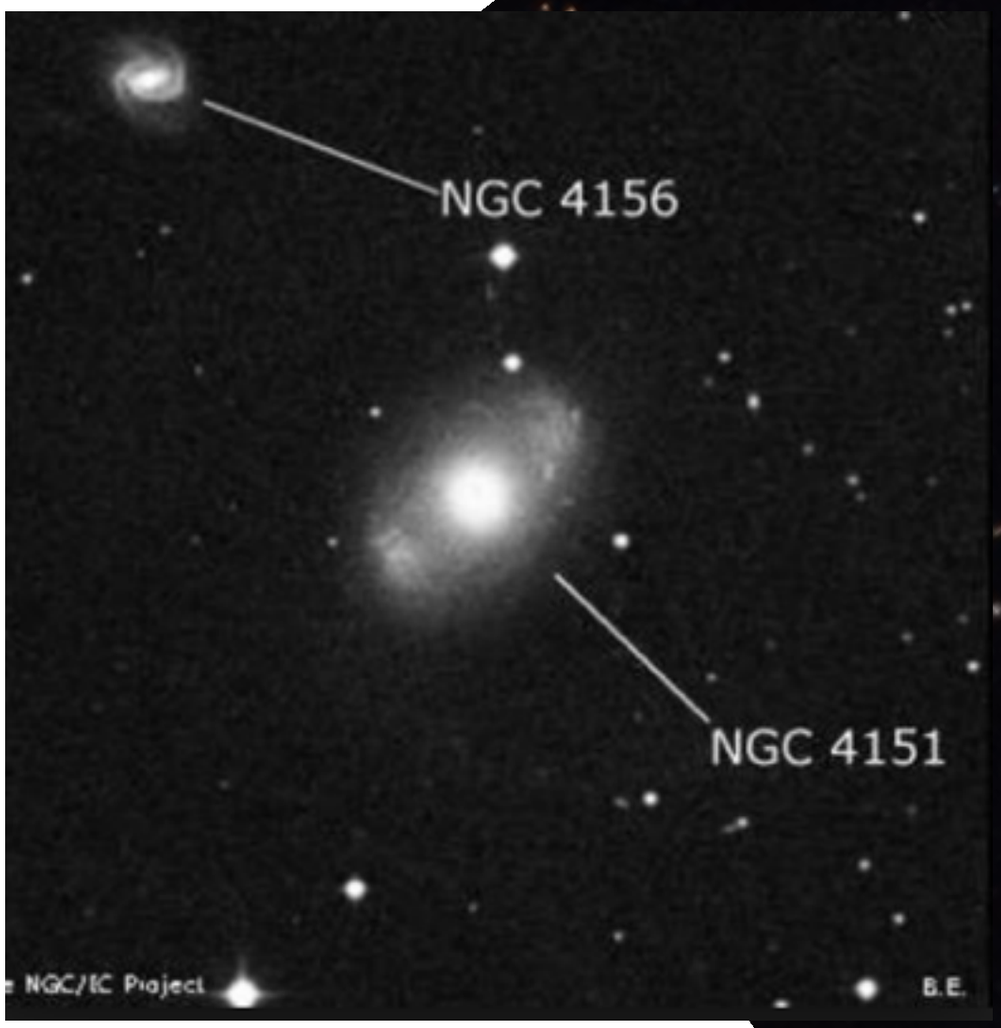
M-sigma



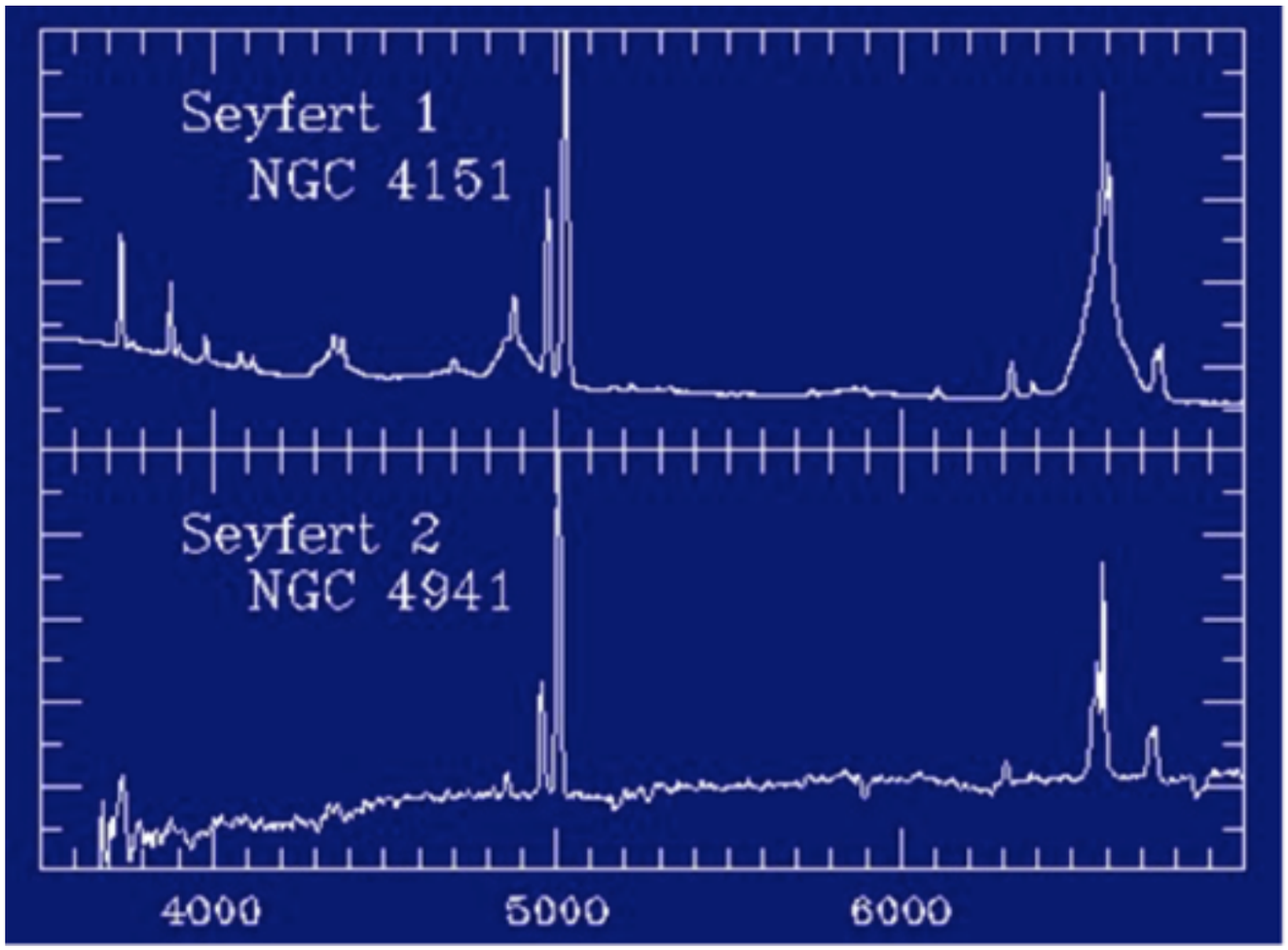
Magorrian

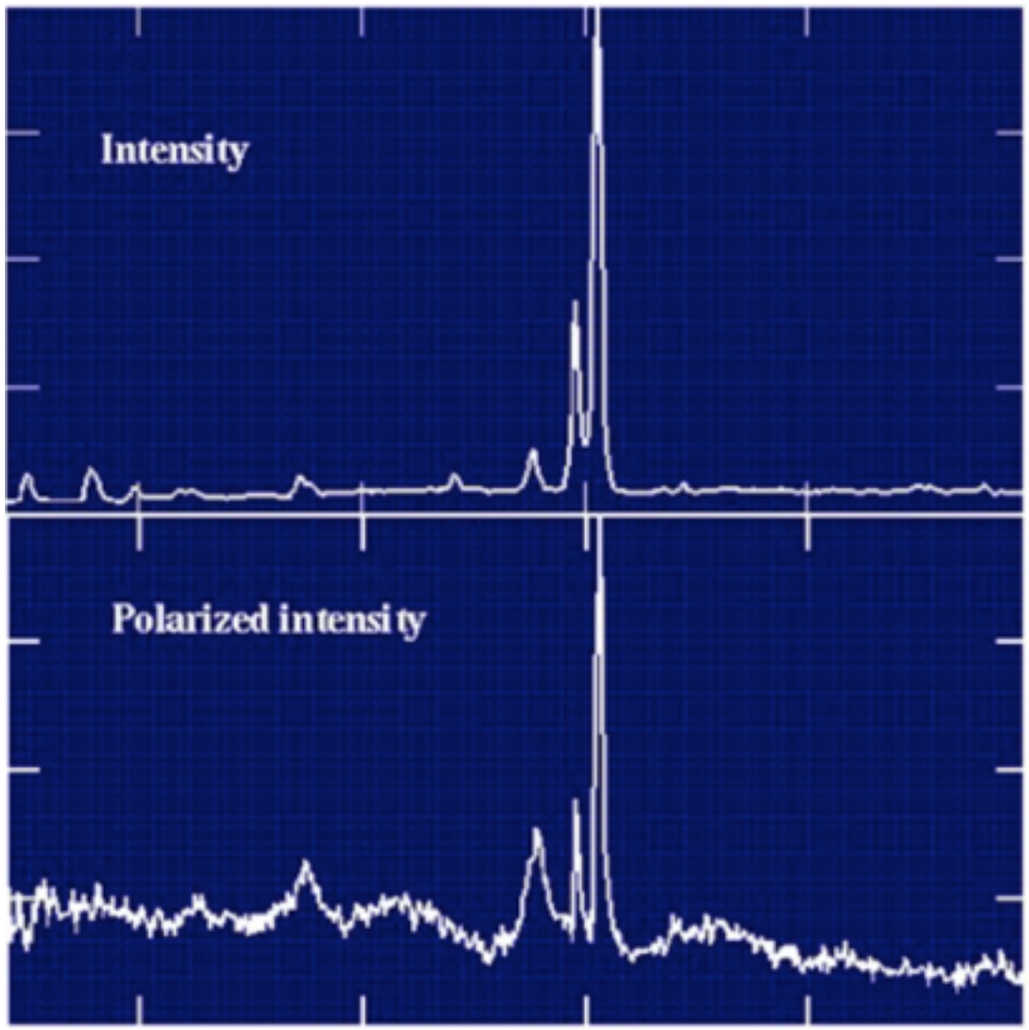
from Gultekin et al 2006

Seyfert galaxies



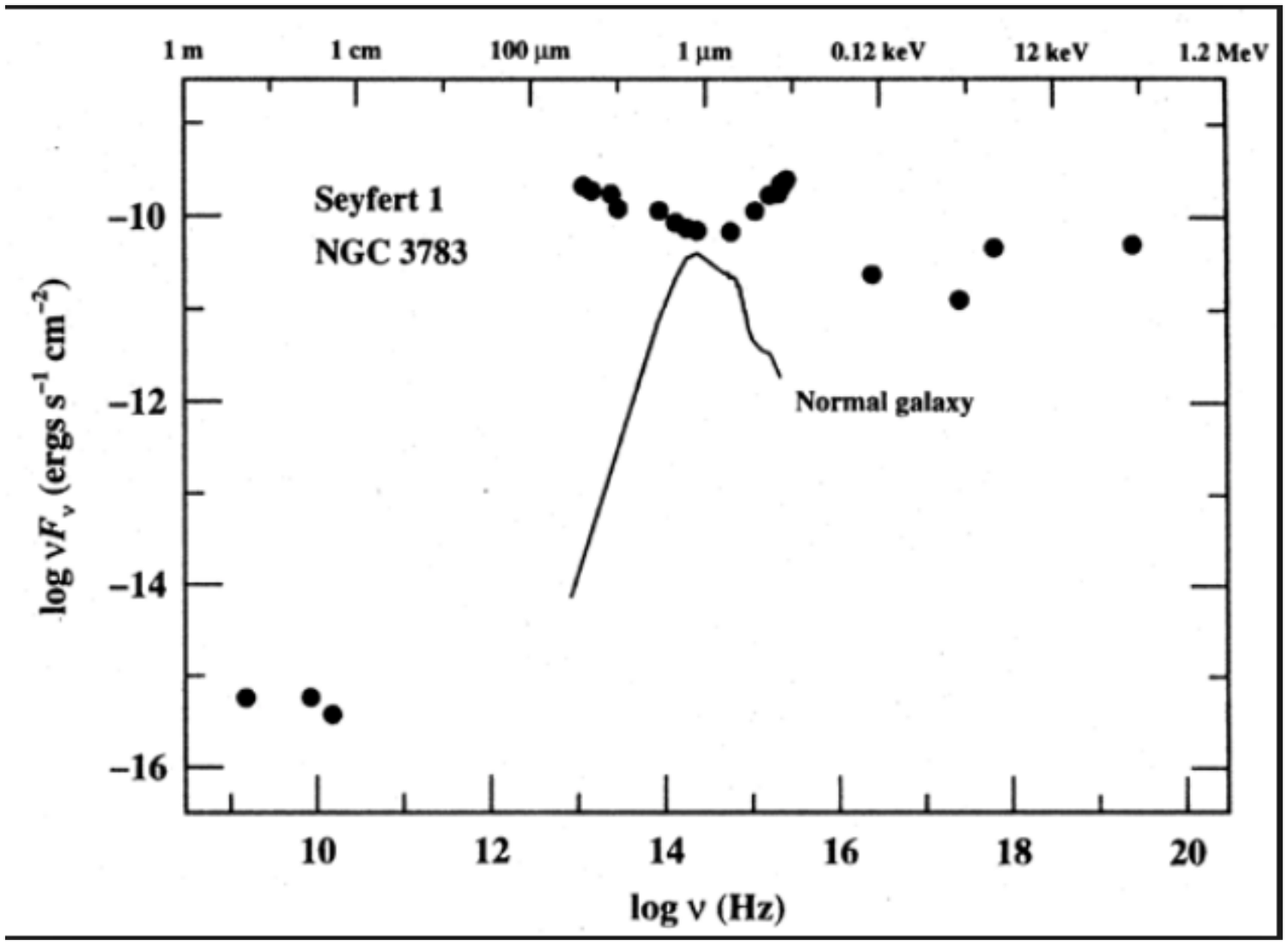
Seyfert 1 vs Seyfert 2 spectra



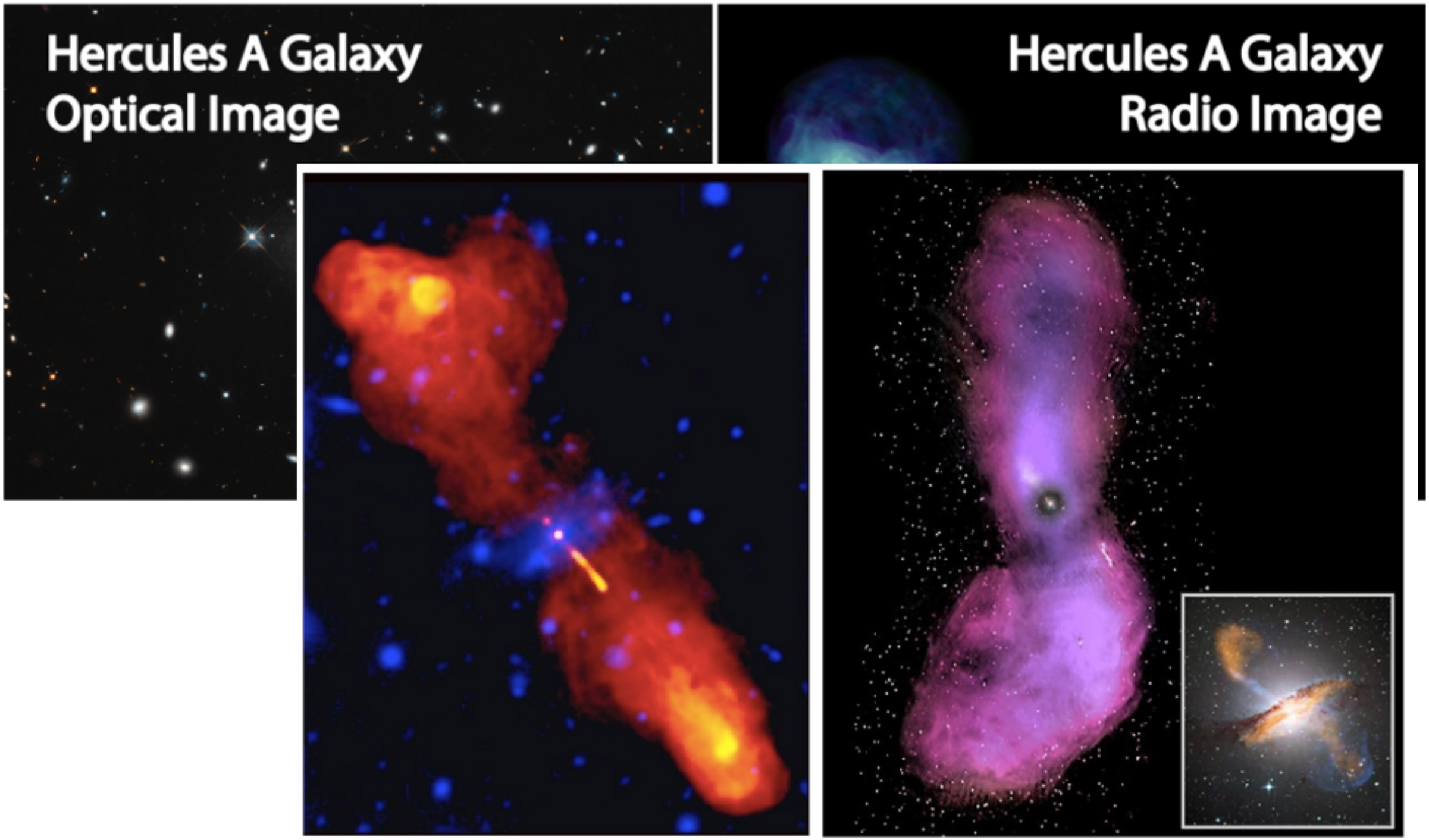


NGC 1068 - Seyfert 2

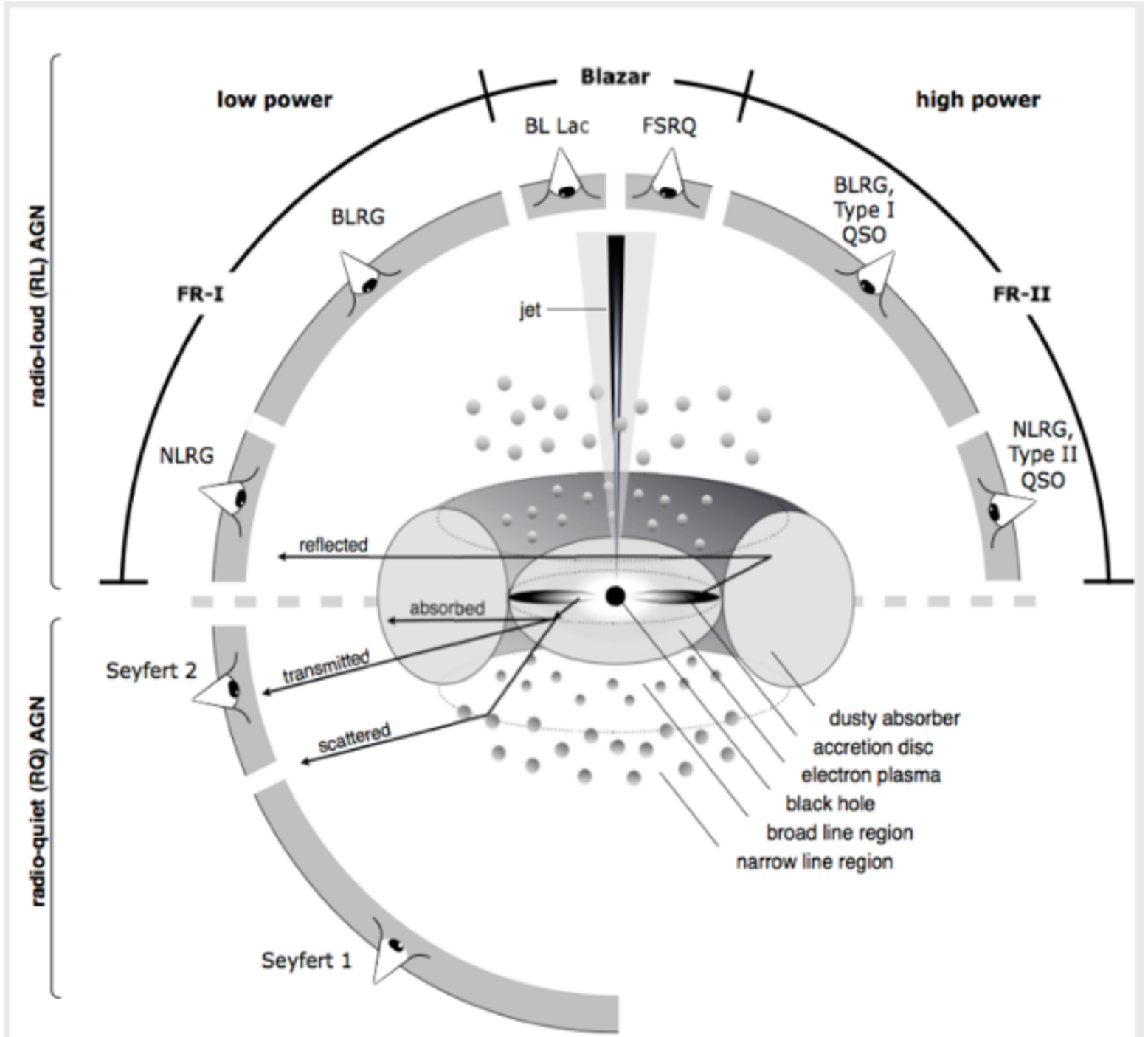
Broadband SED of Seyfert galaxies



Radio galaxies

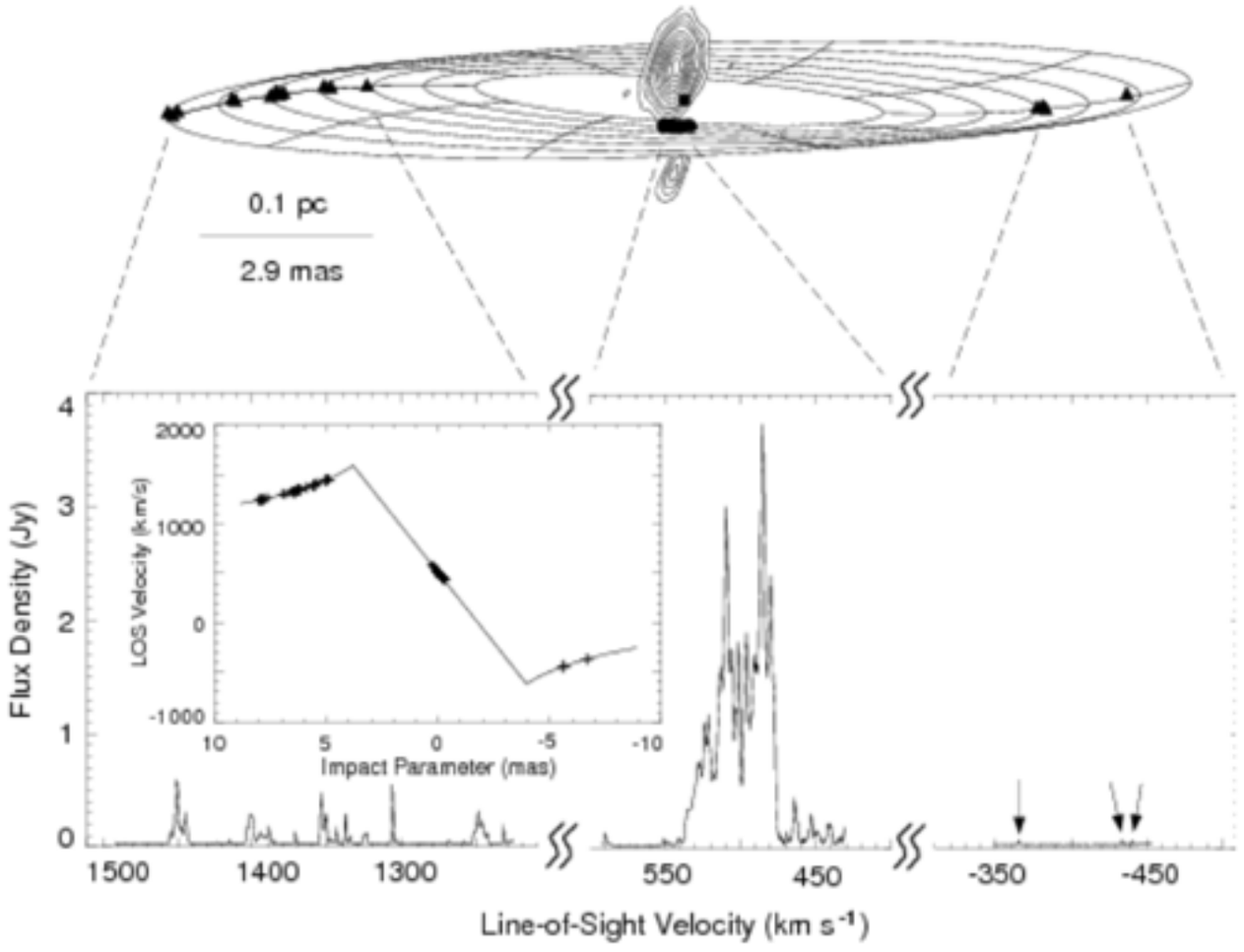


Modello unificato degli AGN



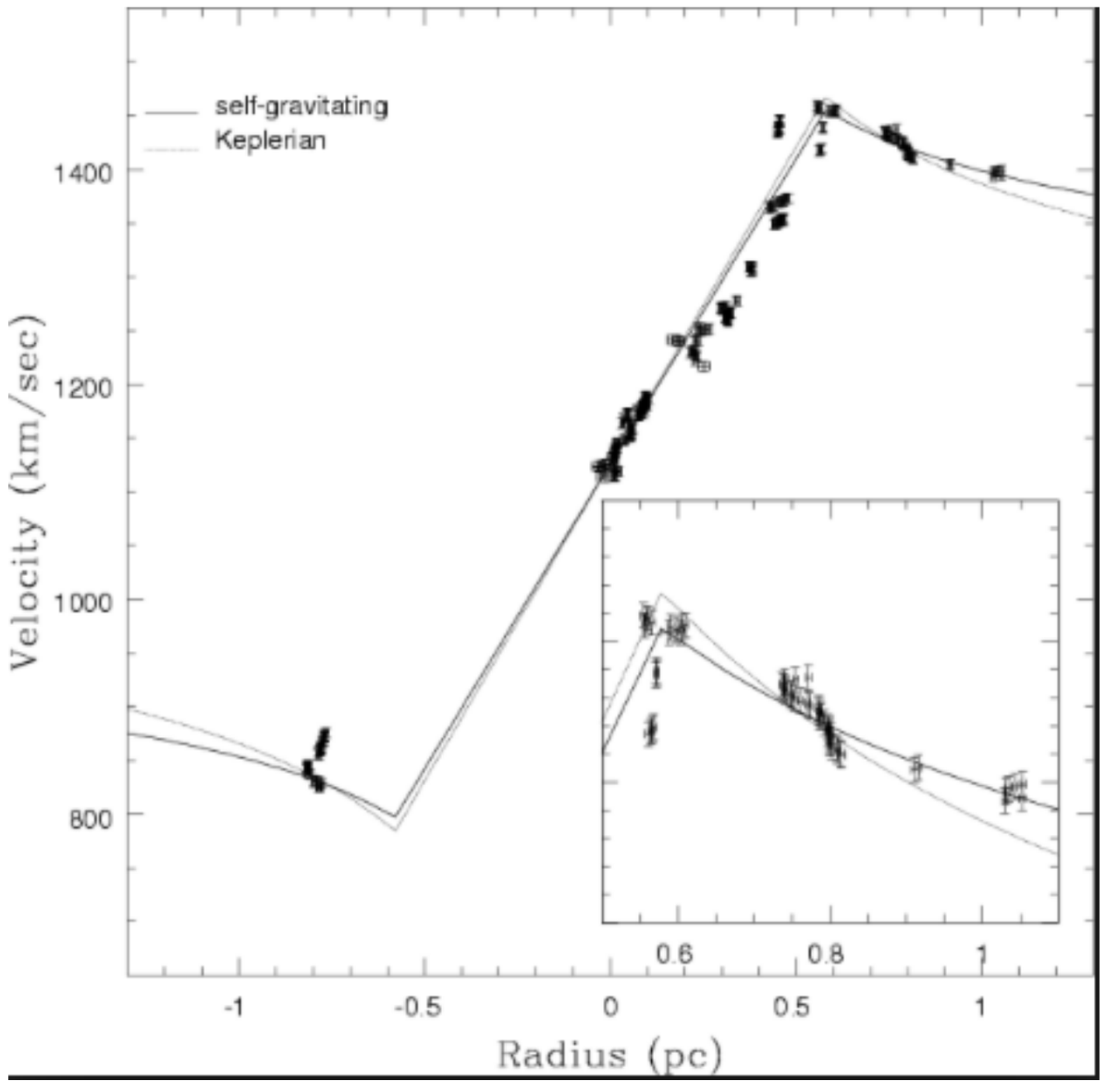
SMBH mass from MASER emission

- NGC 4258: $M_{BH} = 4\ 10^7\ M_{sun}$

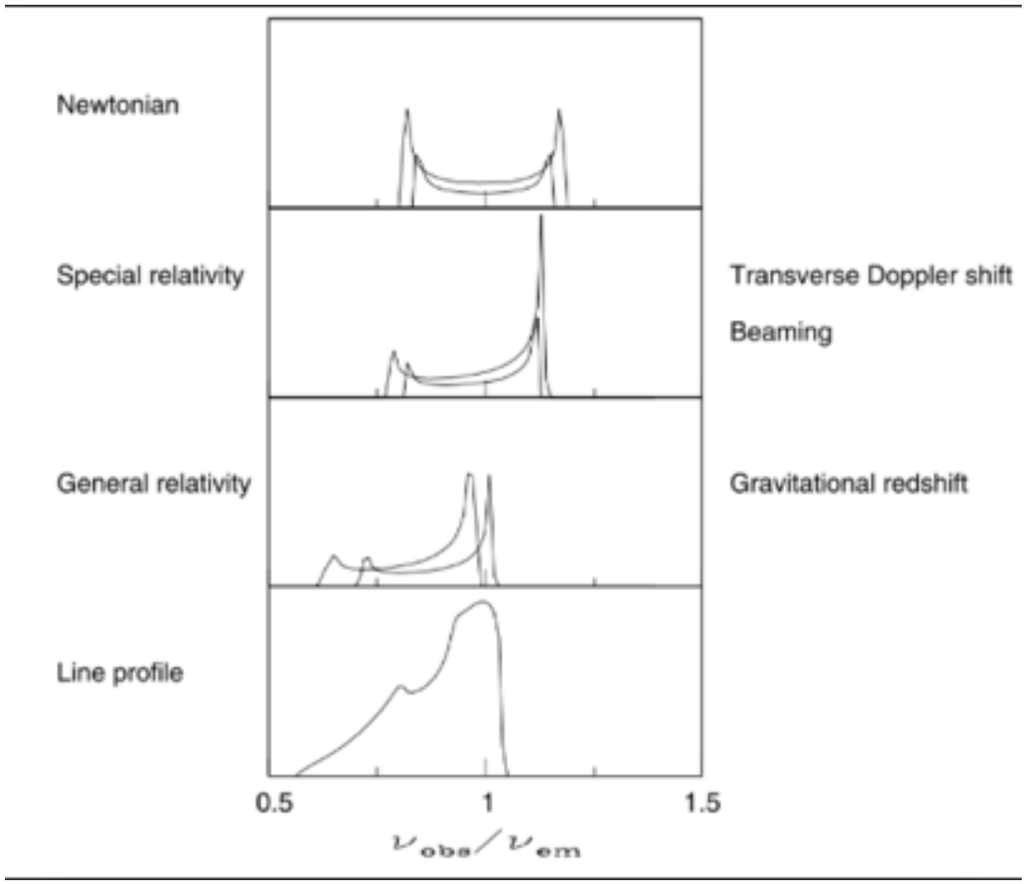


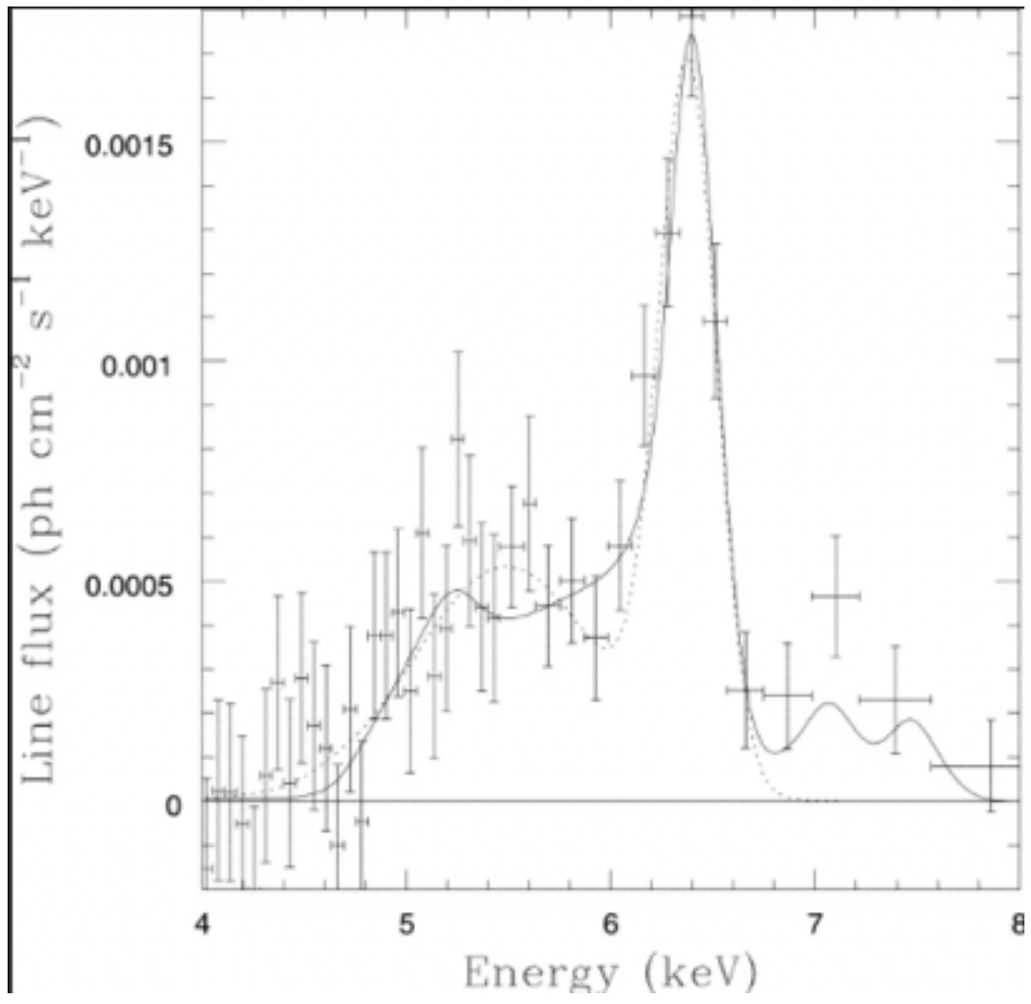
SMBH mass from MASER emission

- NGC 1068: $M_{BH} = 8\ 10^6\ M_{sun}$



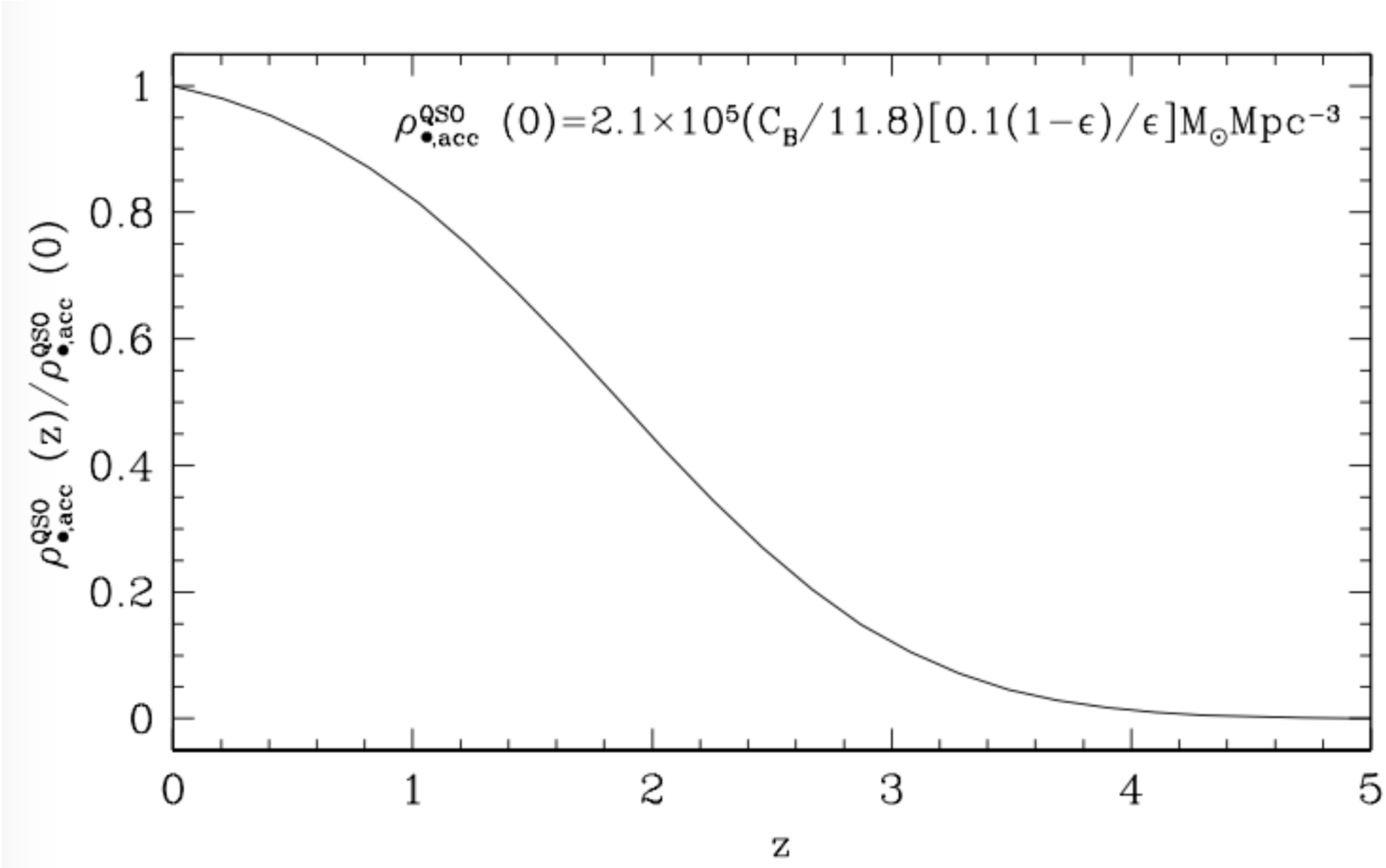
Righe Kalpha del ferro





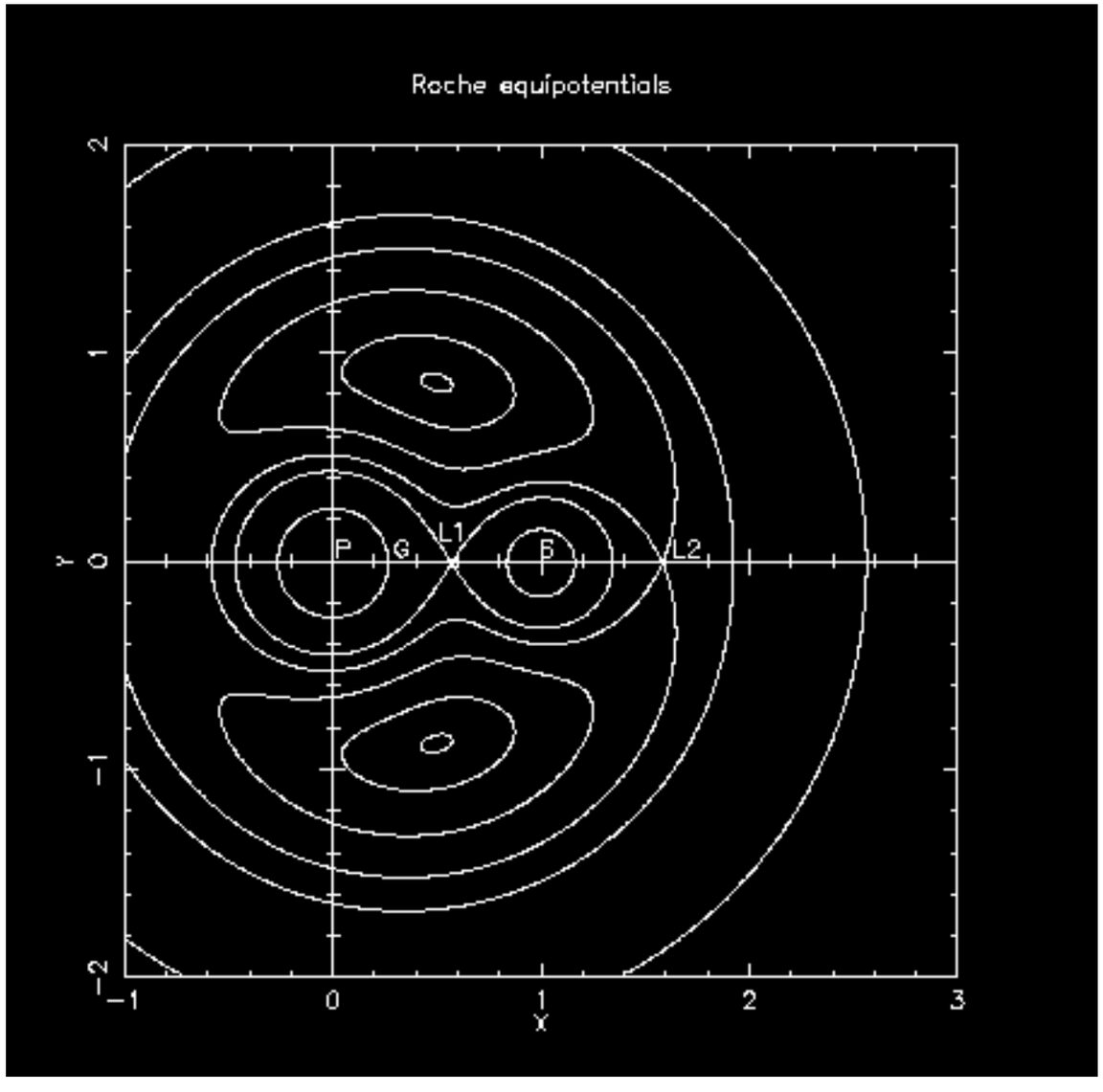
Riga osservata in NGC 4151

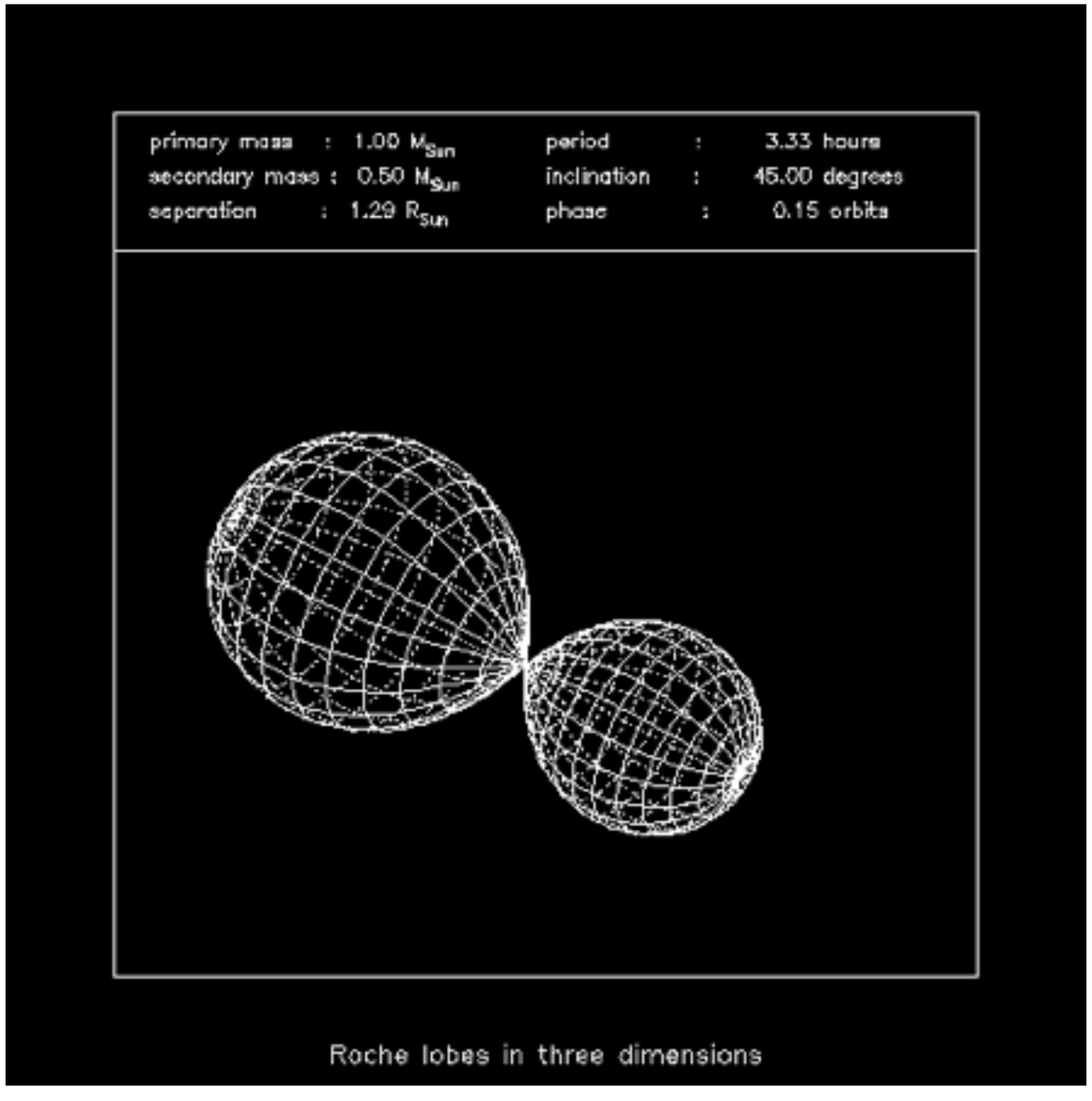
Densità di massa dei buchi neri dal Soltan argument



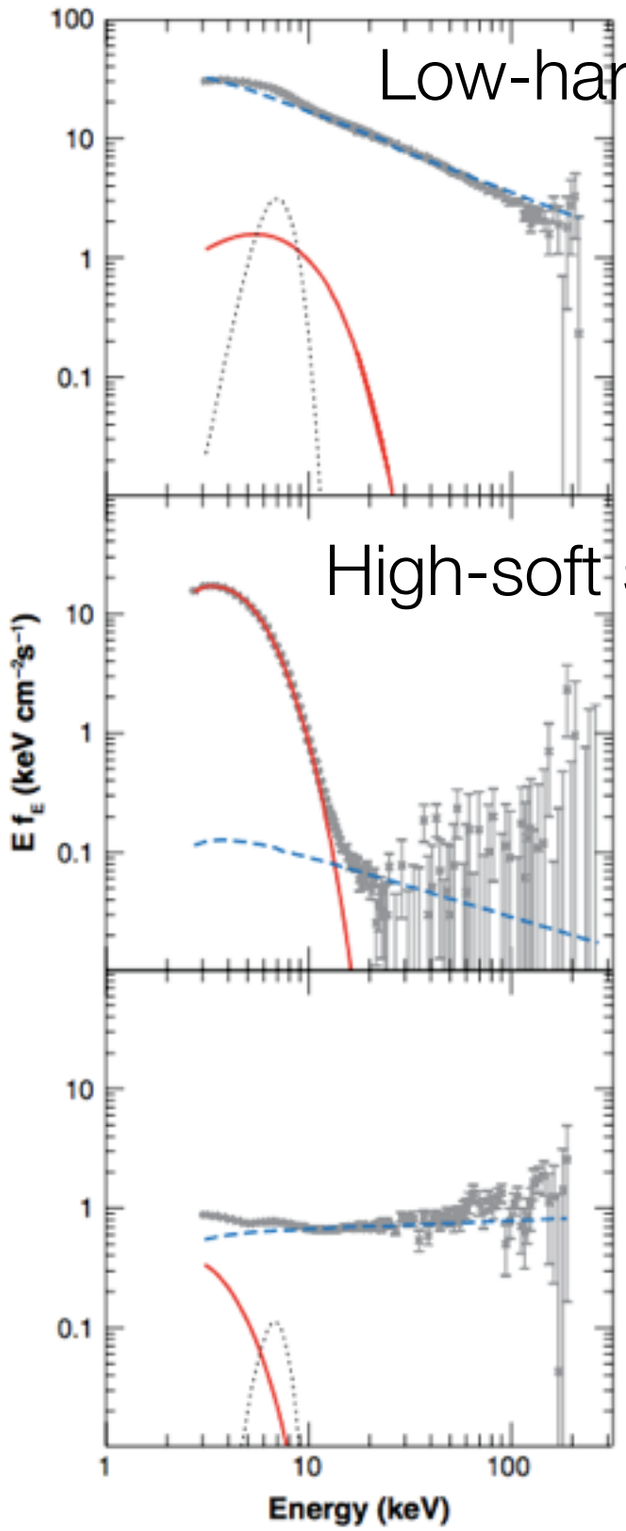
Yu & Tremaine 2002

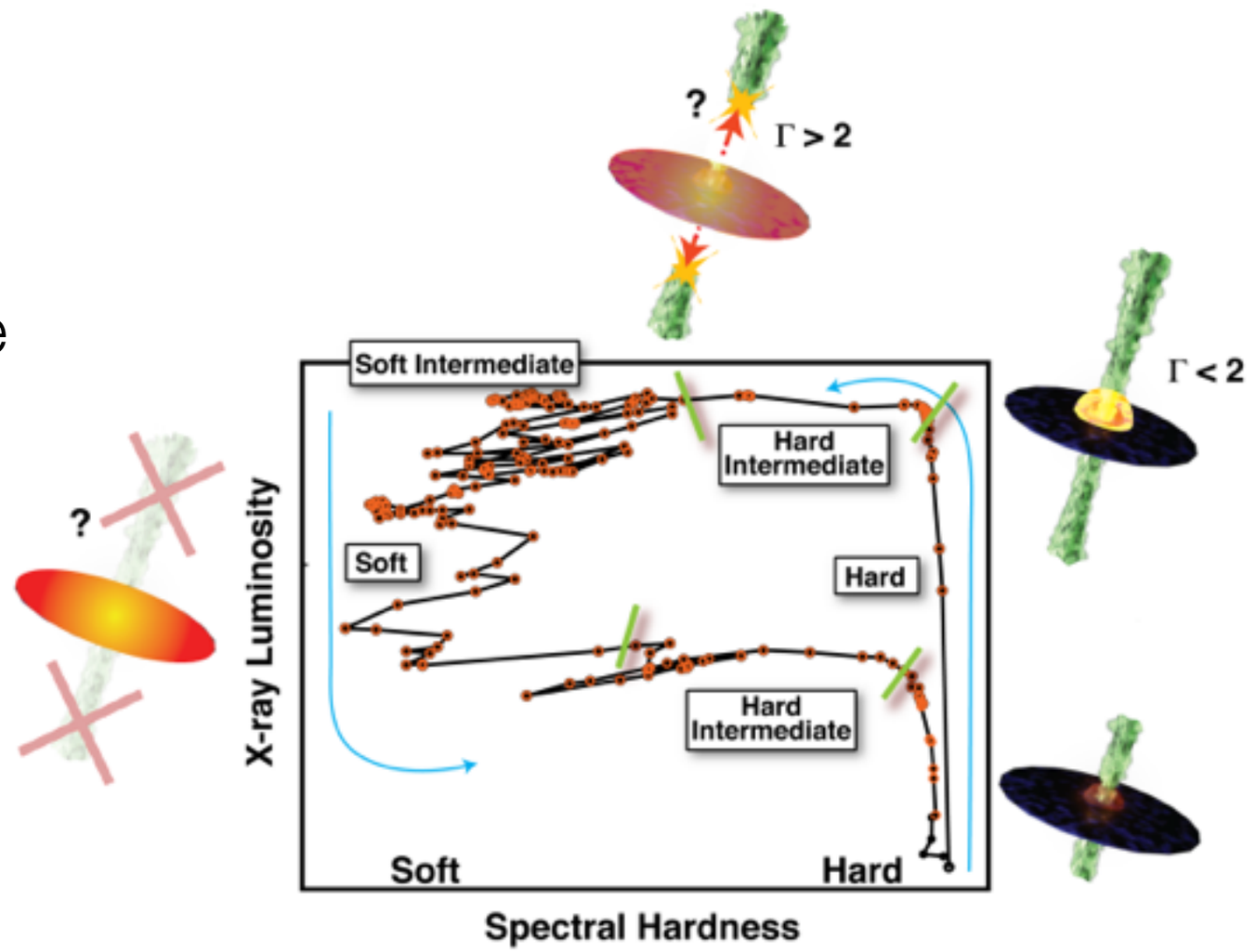
Roche lobes


Roche equipotentials
P
G
L1
B
L2
X
Y
−1
0
1
2
3
−2
−1
0
1
2

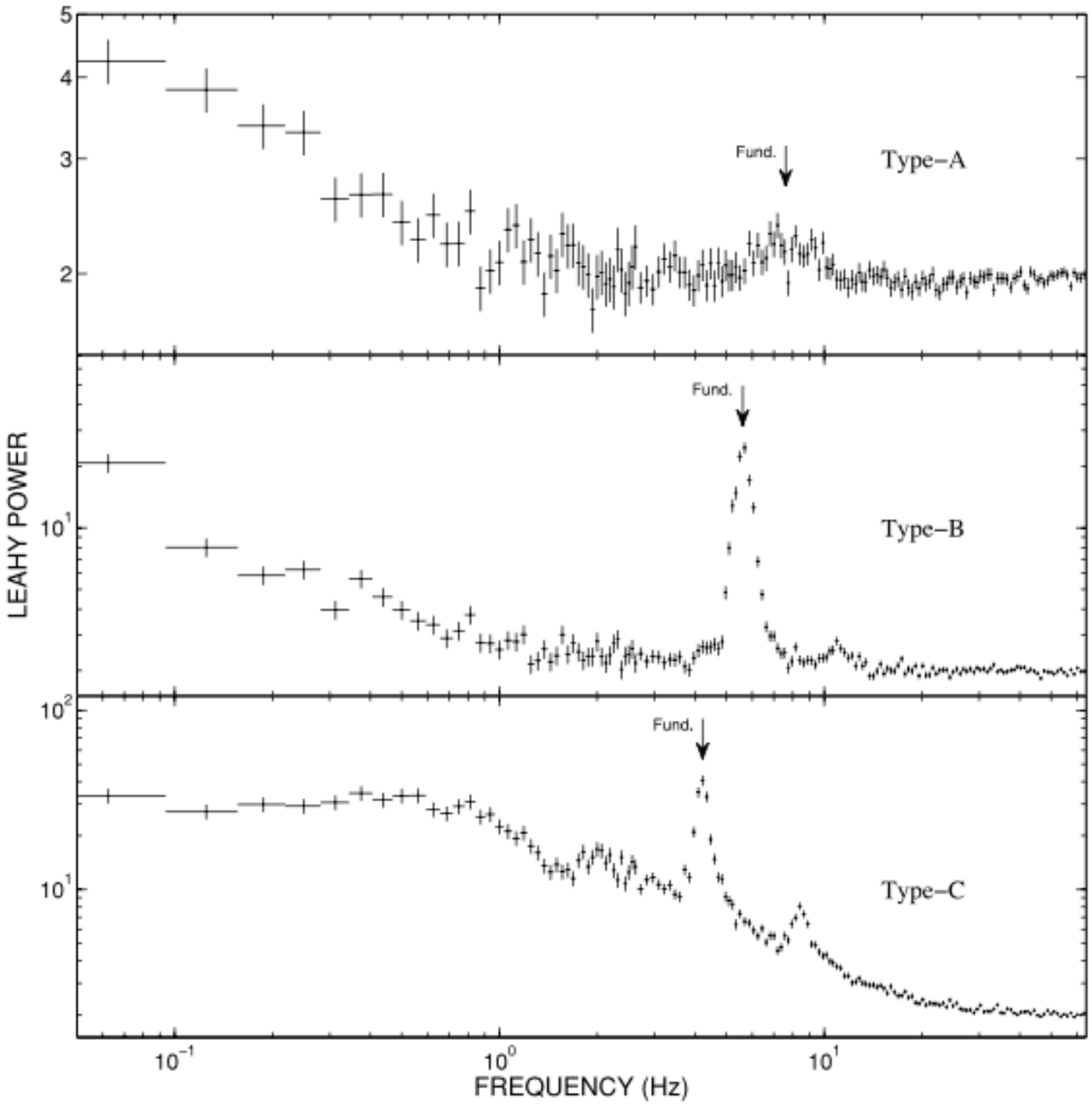

primary mass : 1.00 M_{Sun}
secondary mass : 0.50 M_{Sun}
separation : 1.29 R_{Sun}
period : 3.33 hours
inclination : 45.00 degrees
phase : 0.15 orbits
Roche lobes in three dimensions

Stati spettrali delle X-ray binaries

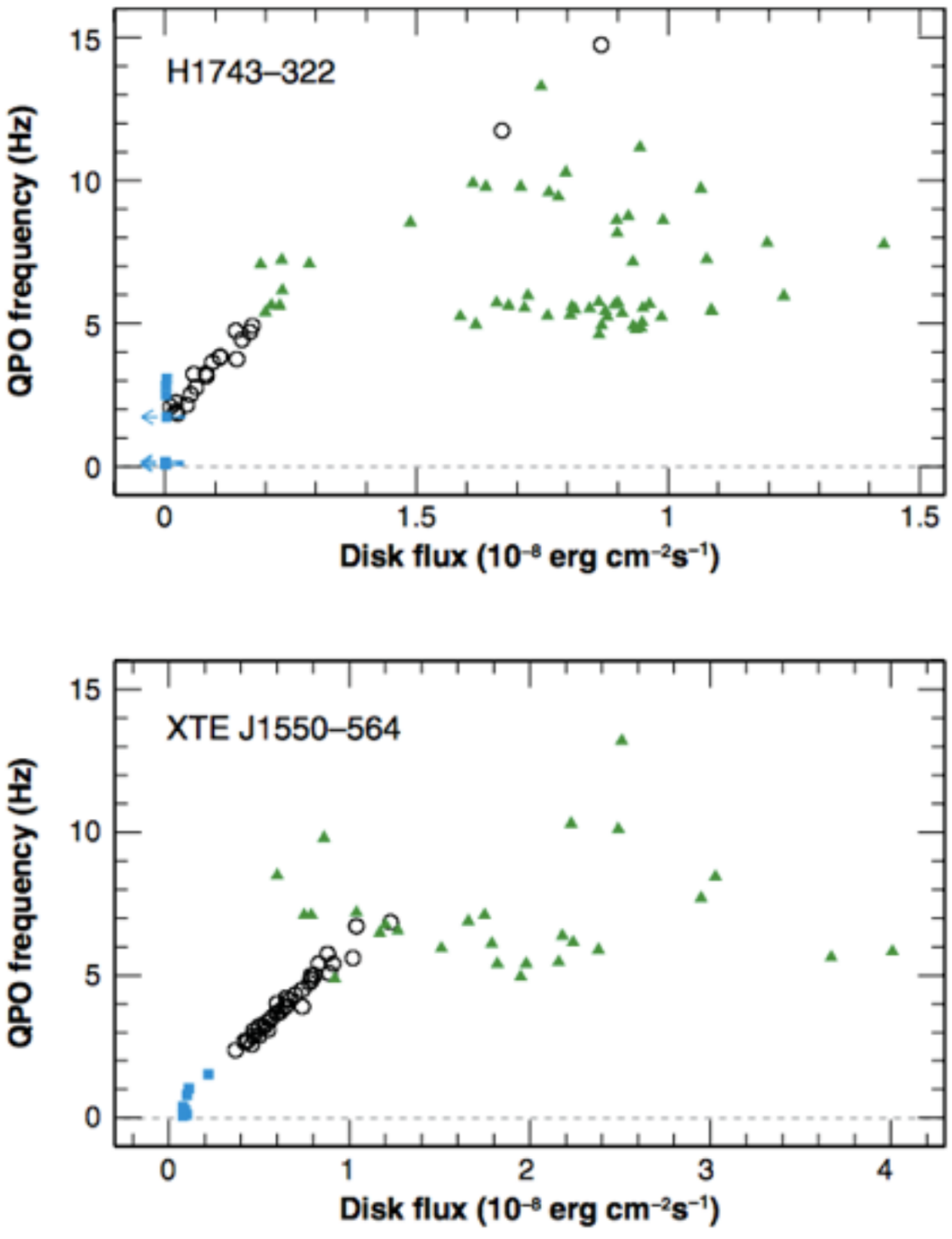




Esempi di LFQPO in BH systems

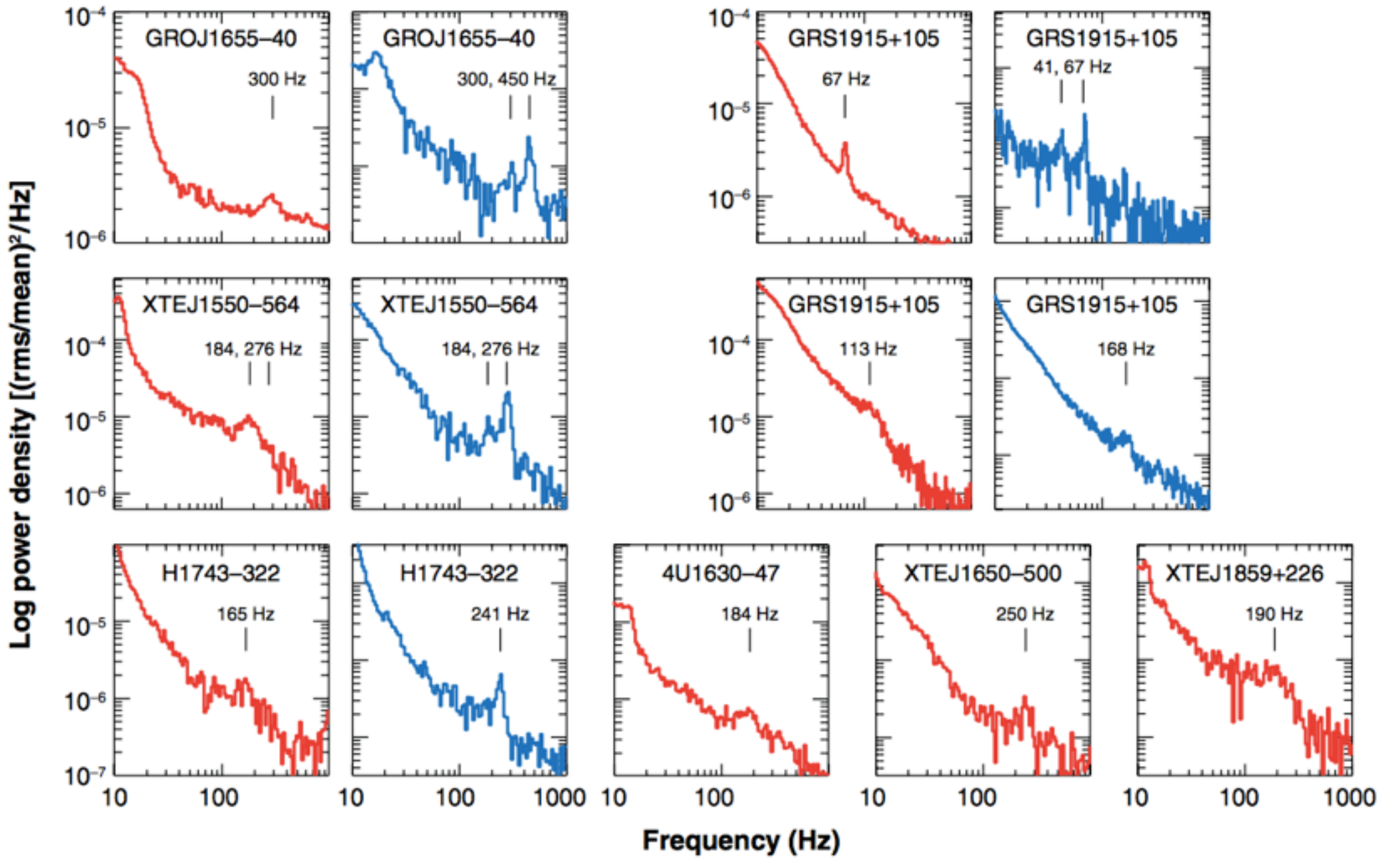


Type C QPO



Frequenza dipende dallo stato spettrale

Esempi di High-frequency QPO in BH systems

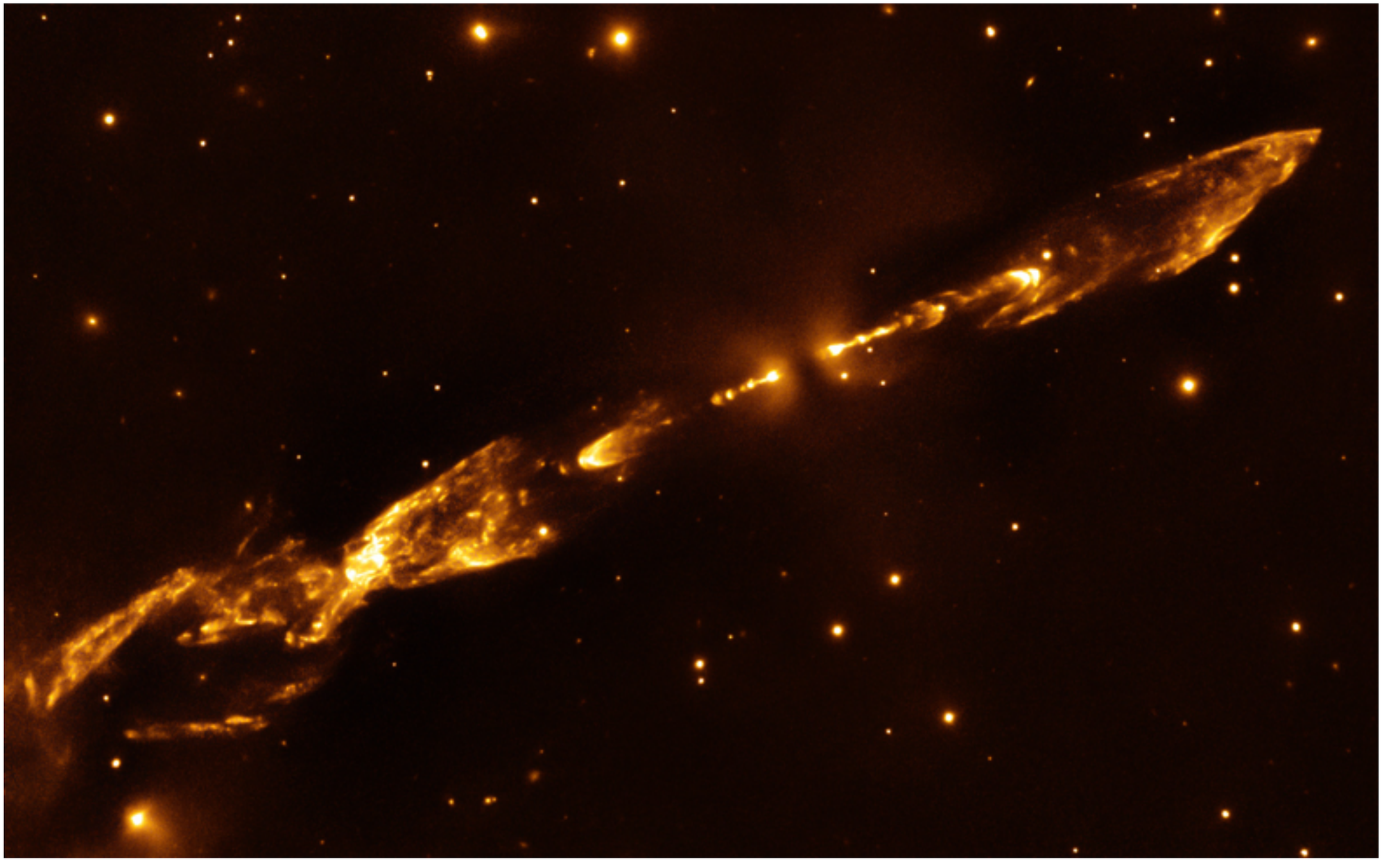


Misure di spin di stellar mass BHs

Object (by RA)	Disk Reflection	Disk Continuum	References
M33 X-7		$a = 0.84 \pm 0.05$	[302, 303]
LMC X-3		$0.21^{+0.18}_{-0.22}$	[222, 305]
LMC X-1	$0.97^{+0.02}_{-0.13}$	$0.92^{+0.05}_{-0.07}$	[343, 344]
A 0620−00		$0.12^{+0.19}_{-0.19}$	[345]
GS 1124−683		$-0.24^{+0.05}_{-0.64}$	[346]
4U 1543−475	0.3 ± 0.1	0.8 ± 0.1	[257], [347]
XTE J1550−654	0.55 ± 0.22	$0.34^{+0.37}_{-0.45}$	[257, 348]
4U 1630−472	$0.985^{+0.005}_{-0.014}$		[349]
XTE J1650−500	0.79 ± 0.01		[276, 257]
XTE J1652−453	0.45 ± 0.02		[258]
GRO J1655−40	0.98 ± 0.01	0.7 ± 0.1	[257, 347]
GX 339−4	0.94 ± 0.02		[257]
SAX J1711.6−3608	$0.6^{+0.2}_{-0.4}$		[257]
XTE J1752−223	0.52 ± 0.11		[259]
Swift J1753.5−0127	$0.76^{+0.11}_{-0.15}$		[350]
MAXI J1836−194	0.88 ± 0.03		[351]
XTE J1908+094	0.75 ± 0.09		[350]
Swift J1910.2−0546	≤ -0.32		[352]
GRS 1915+105	0.98 ± 0.01	≥ 0.95	[238, 275]
Cygnus X-1	$0.97^{+0.01}_{-0.02}$	≥ 0.95	[297, 296]

Getti da dischi protostellari

Oggetti Herbig-Haro



Rivelazione di GW da LIGO