

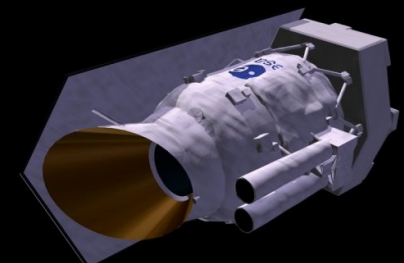
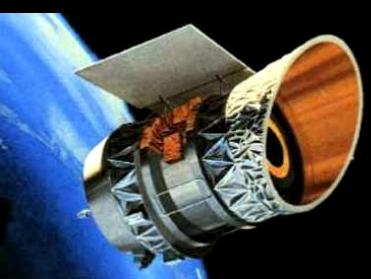
HYPER-LUMINOUS INFRARED GALAXIES

An X-ray view

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HLIRGs: Introduction

➤ LIRGs: $L_{\text{IR}} > 10^{11} L$

➤ ULIRGs: $L_{\text{IR}} > 10^{12} L$

➤ HLIRGs: $L_{\text{IR}} > 10^{13} L$

HLIRGs: Introduction

- ~50 detected HLIRGs, ~100-200 estimated with $60\mu\text{m}$ flux >200 mJy over the whole sky.
- Unique laboratories to investigate extremely high star formation ($\sim 1000 \text{ M /yr}$) and its connection to supermassive black holes.
- Evolutionary connection: QSO \leftrightarrow ULIRG \leftrightarrow HLIRG
- Cosmic X-ray and infrared background.

HLIRGs: Introduction

Three hypothesis:

- A. **High-luminosity tail of the ULIRGs**: starburst and/or AGN triggered by interactions and mergers.
- B. **Very young galaxies** during their maximal star formation episode.
- C. IR emission via **other mechanism** (different new class of object): e.g. transient IR luminous phase in the QSO evolution.

HLIRGs: Samples

➤ Sub-samples from Rowan-Robinson (2000):

➤ Farrah et al. 2002:

Detected HLIRGs in FIR or submm surveys. Complete, homogeneous and unbiased to AGNs.

(8 sources with our own XMM data in the future)

➤ XMM-sample:

➤ All sources with **public data in the XMM-Newton archive** in December 2004, and redshift between ~ 0.3 y ~ 1.5 .
(9 sources, 2 from Farrah sample)

➤ Previous results suggest that some sources could be highly obscured and no direct X-ray emission is detected: **Compton-thick sources**.

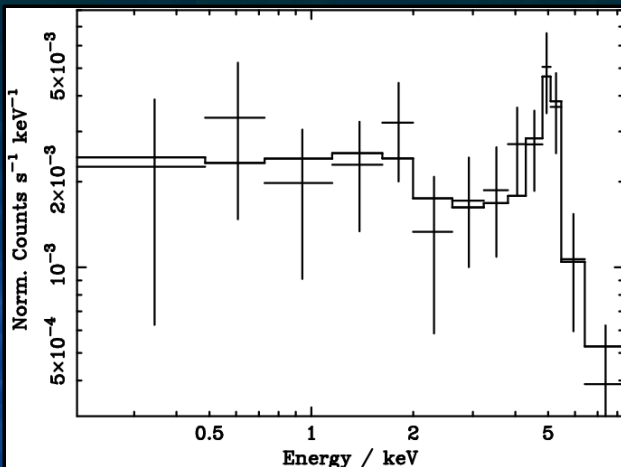
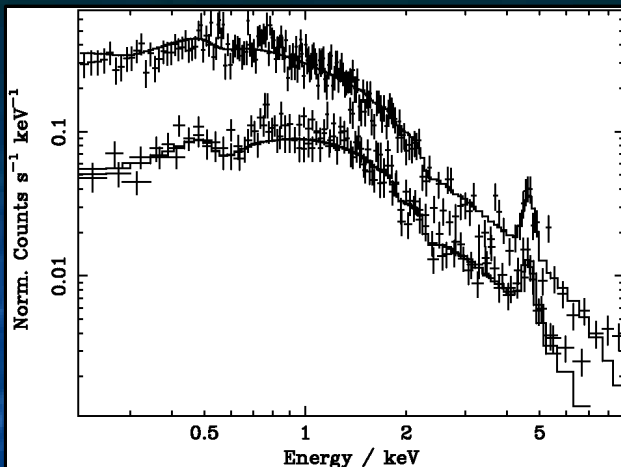
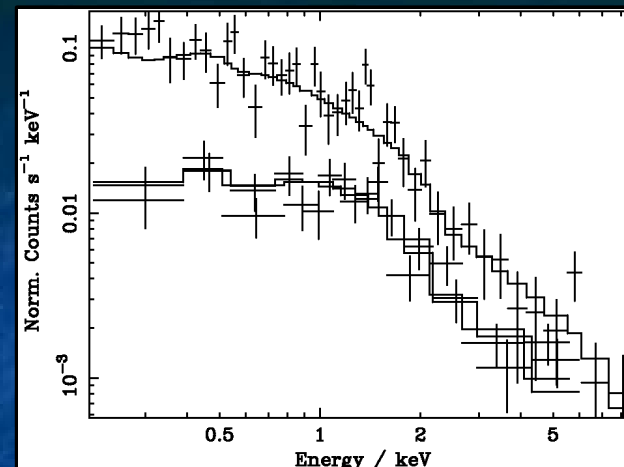
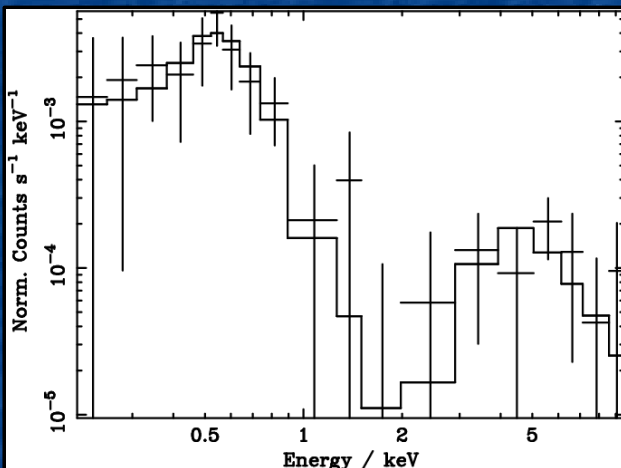
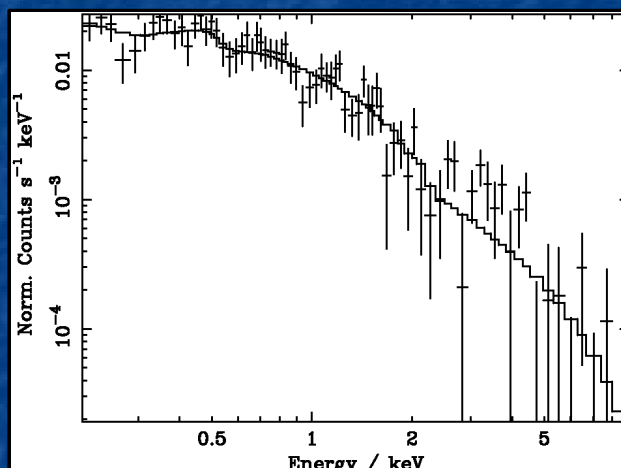
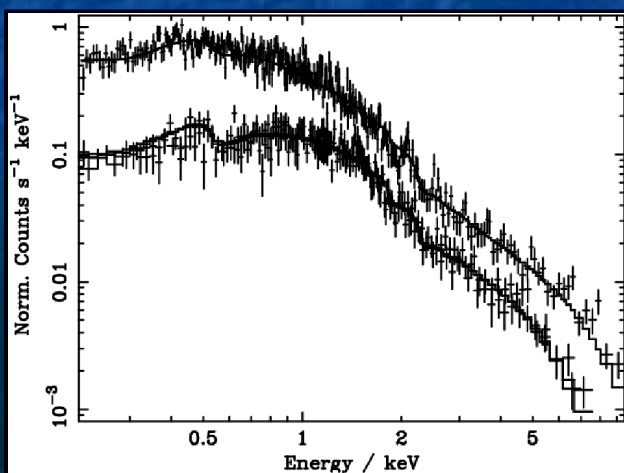
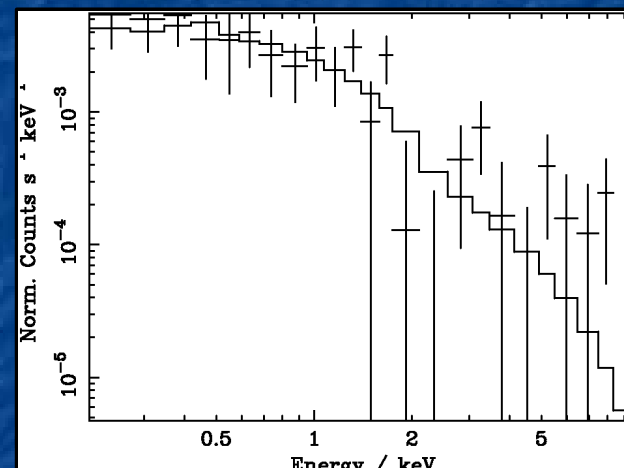
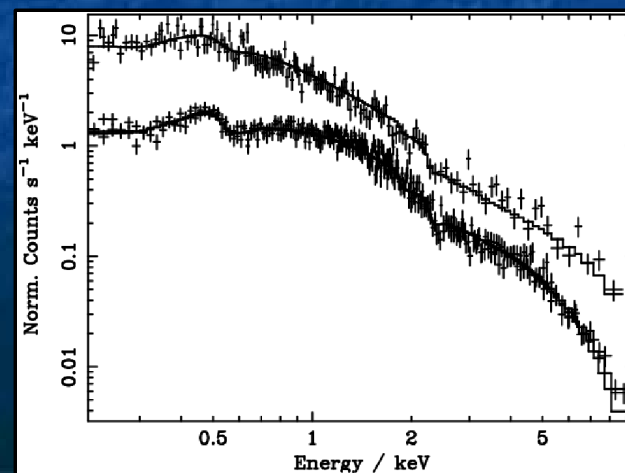
➤ Franceschini et al. 2003: **ULIRGs comparison sample**.

HLIRGs: Sample

<i>Source</i>	<i>Type</i>	<i>z</i>	<i>RA</i>	<i>DEC</i>
IRAS F00235+1024	Starburst	0.575	00 26 06.5	+10 41 32
IRAS 00182-7112	LINER	0.327	00 20 34.7	-70 55 27
IRAS 09104+4109	Seyfert 2	0.442	09 13 45.4	+40 56 28
IRAS 12514+1027	Seyfert 2	0.3	12 54 00.8	+10 11 12
IRAS F15307+3252	Seyfert 2	0.926	15 32 44.0	+32 42 47
PG 1206+459	QSO	1.158	12 08 58.0	+45 40 36
IRAS F14218+3845	QSO	1.21	14 23 55.0	+38 32 14
IRAS 16347+7037	QSO	1.334	16 34 28.9	+70 31 33
IRAS 18216+6418	QSO	0.297	18 21 57.3	+64 20 36

HLIRGs: Objectives





- Determine the **relative contribution of AGN and starburst** emission to the bolometric luminosity and their interplay.
- X-ray study contributes:
 - Search of “hard” (2-10 keV) **non thermal emission** (associated to AGN or HMXB from the starburst).
 - Search of “soft” (0.2-2 keV) emission using thermal models (probably associated to starburst): **Thermal emission.**
 - Search of **absorption** features and FeK emission lines.

IRAS 00182-7112**IRAS 09104+4109****PG 1206+459****IRAS 12514+1027****IRAS F14218+3845****IRAS F15307+3252****IRAS 16347+7037****IRAS18216+6418**

HLIRGs: Spectral analysis

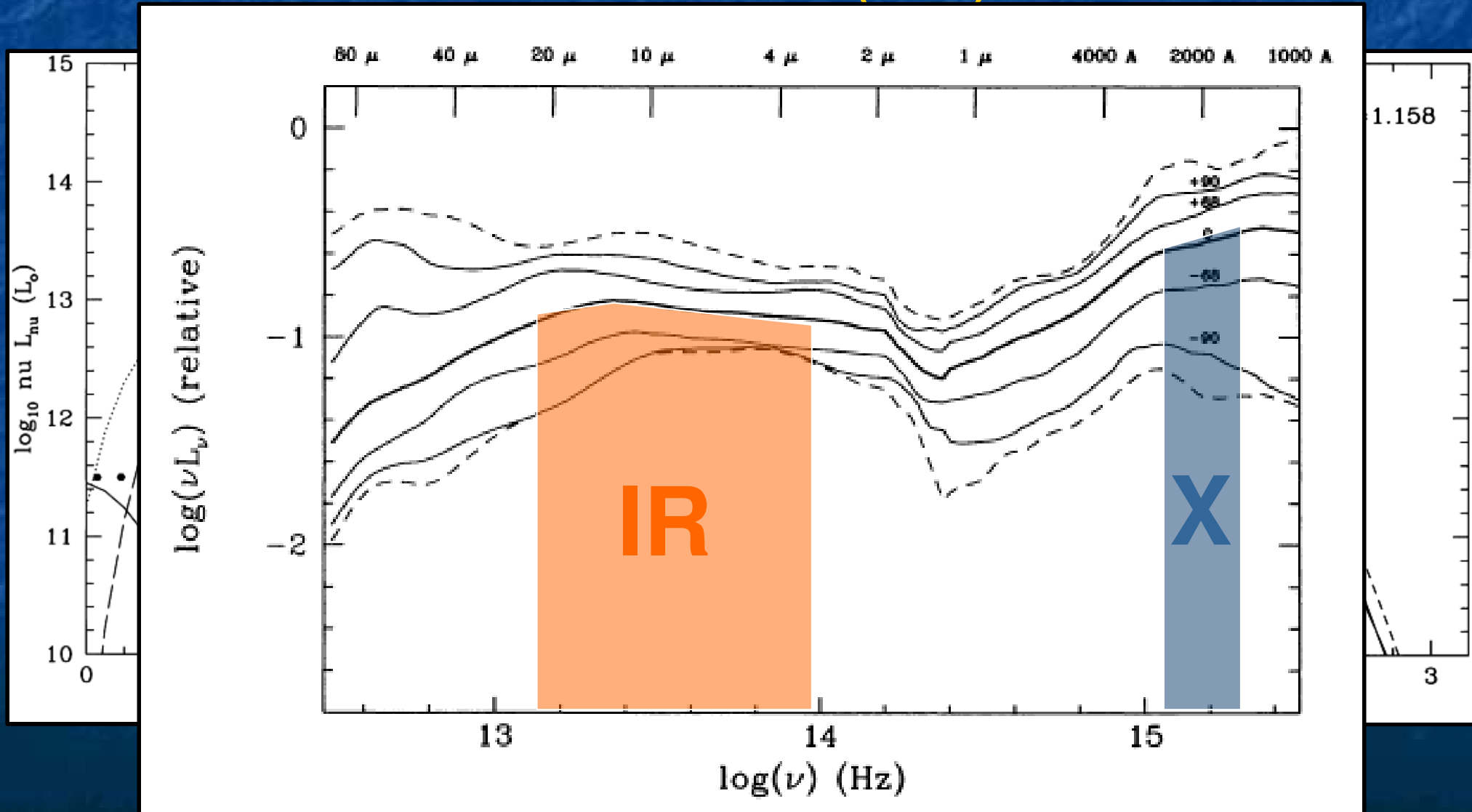
<i>Source</i>	<i>Model</i>	<i>kT</i>	$\text{Log } L_{po}$	$\text{Log } L_{th}$
IRAS F00235+1024	-	0.5	<44.3	<42.4
IRAS 00182-7112	LINE + NTH	0.6	44.8	<41.9
IRAS 09104+4109	LINE + NTH	0.6	44.5	<43.0
IRAS 12514+1027	TH + NTH	$0.35^{+0.17}_{-0.07}$	43.3	42.2
IRAS F15307+3252	NTH	0.6	43.7	<43.1
PG 1206+459	NTH	0.6	45.1	<44.0
IRAS F14218+3845	NTH	0.6	44.6	<43.8
IRAS 16347+7037	TH + NTH	1.53 ± 0.18	46.0	45.7
IRAS 18216+6418	TH + NTH	0.49 ± 0.09	45.6	45.1

TH: Thermal model
NTH: No thermal model
LINE: FeK emission line

 Starburst
 LINER
 Seyfert 2
 QSO

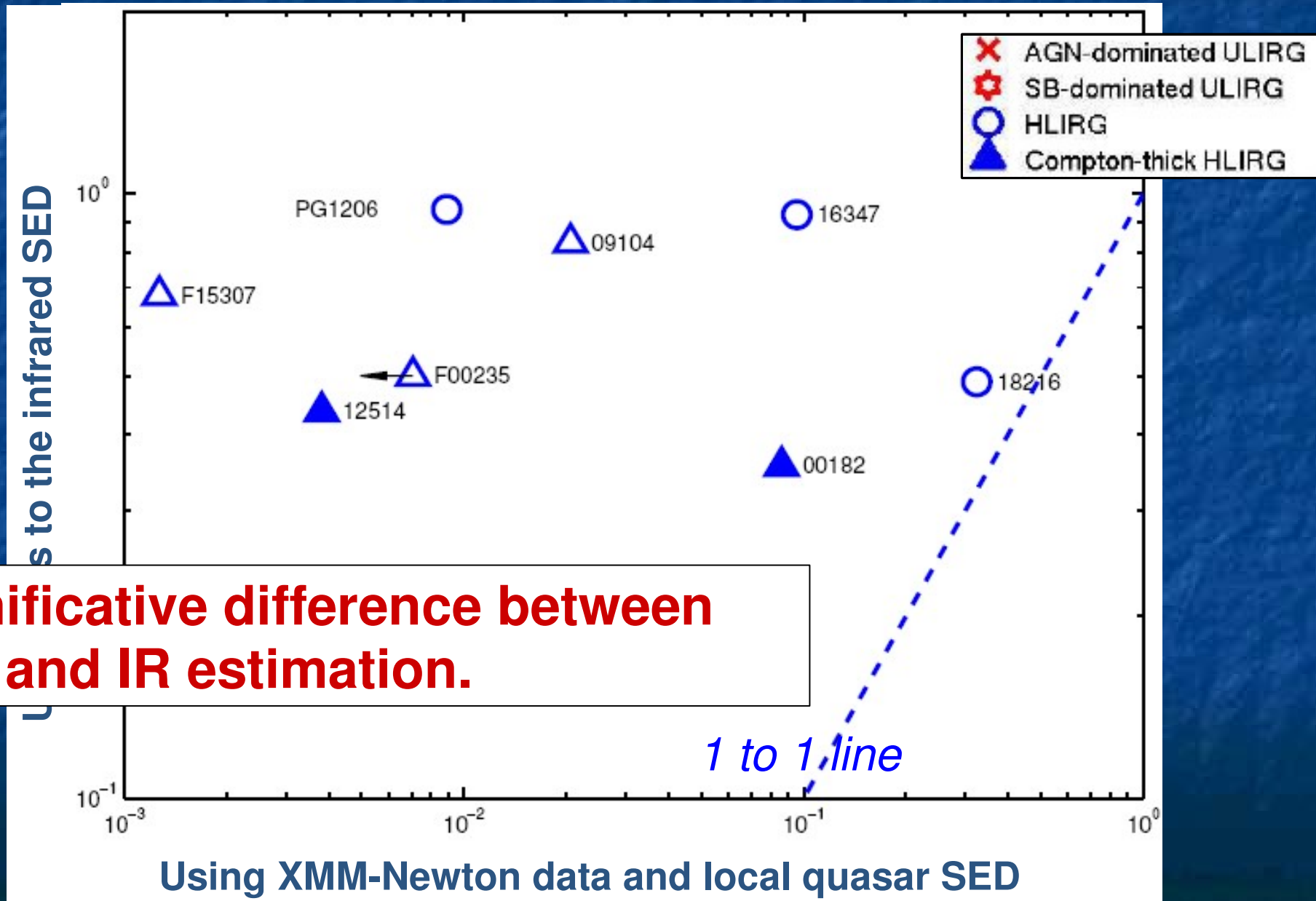
HLIRGs: Discussion (II)

AGN and starburst contribution using infrared SED
Rowan-Robinson (2000)



HLIRGs: Discussion (II)

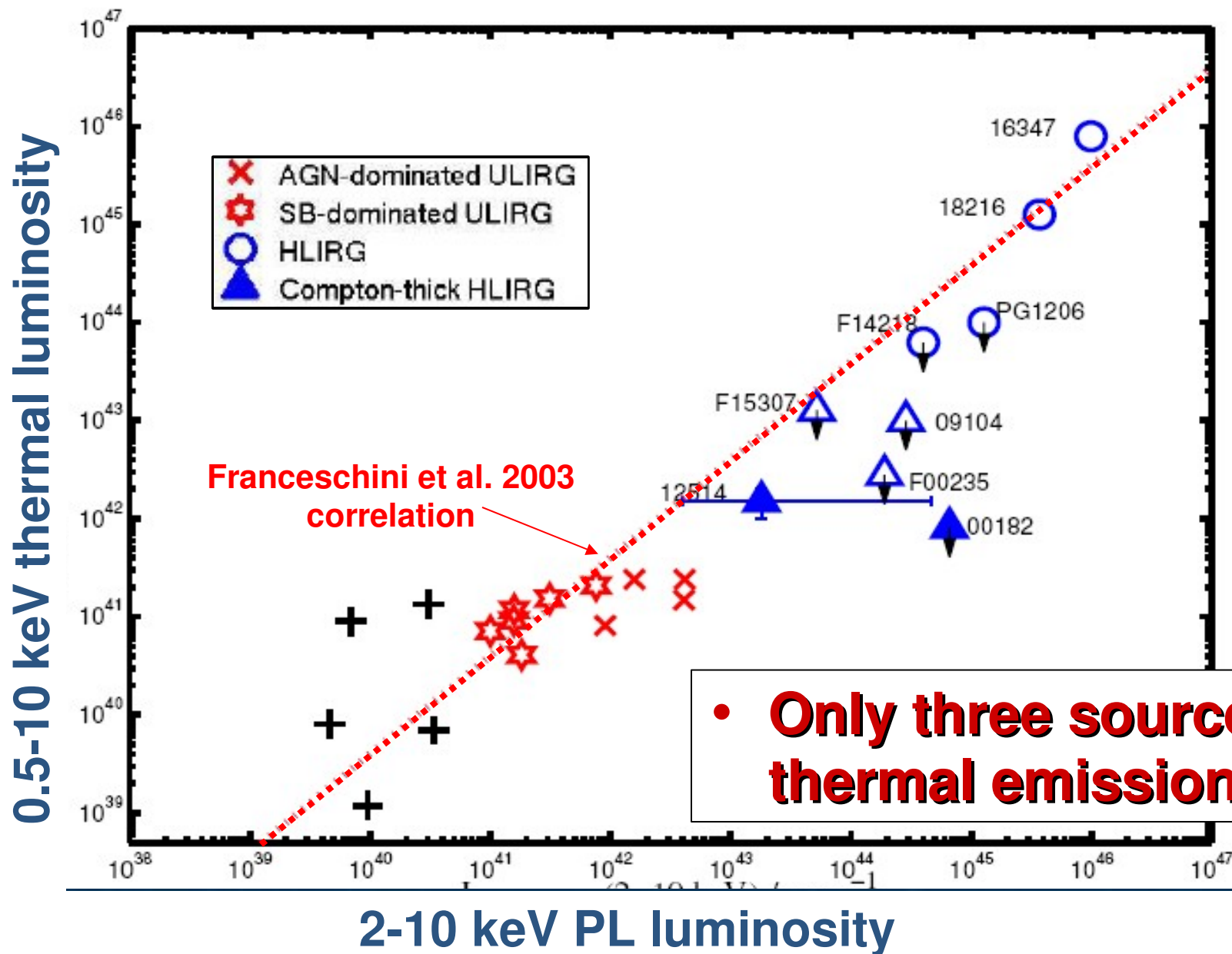
Relative contribution to the infrared emission from the AGN



HLIRGs: Discussion (II)

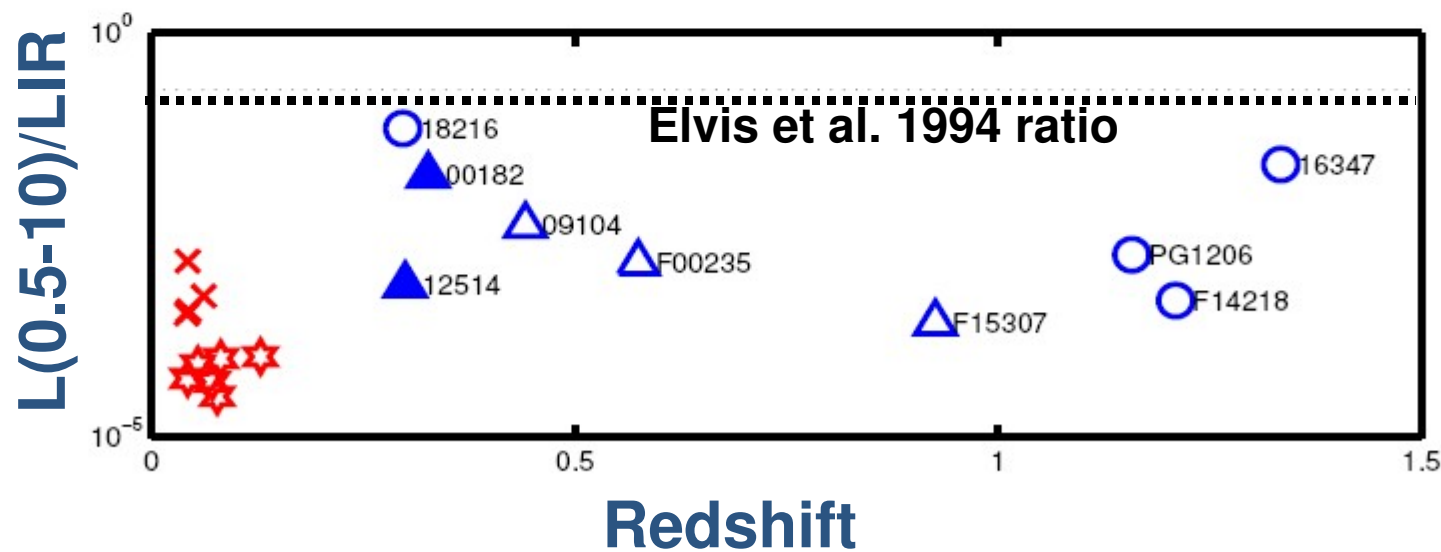
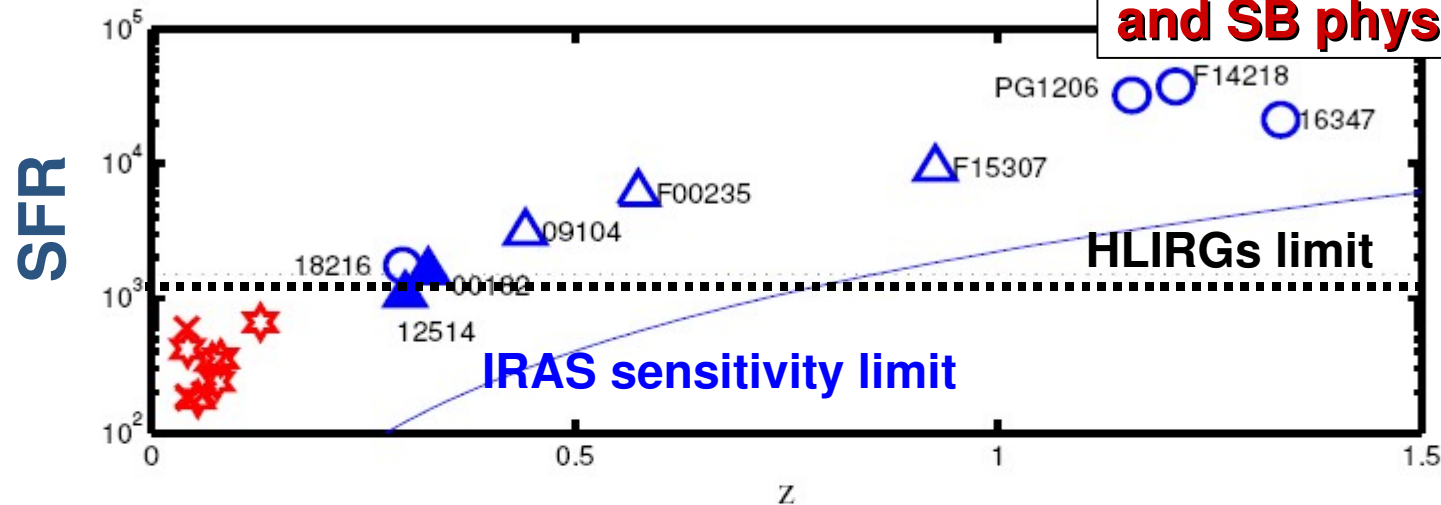
- Two hypothesis:
 - AGN in HLIRGs have a **different SED** from a local QSO (Elvis et al. 1994).
 - **Compton-thick** sources.
- Source by source analysis.

HLIRGs: Discussion (III)



HLIRGs: Discussion (IV)

- SFR evolution probably due to selection effects.
- XR/IR ~constant with z -> AGN and SB physically connected.



- ✕ AGN-dominated ULIRG
- ★ SB-dominated ULIRG
- HLIRG
- ▲ Compton-thick HLIRG

HLIRGs: Conclusion

- Heterogeneous sources.
- Thermal component detected only in three sources. Two of them can not be starburst.
- “**Mixed**” AGN + starburst **sources**.
- **Local quasars SED not valid** in **three** sources (intrinsic AGN infrared excess).
- Absorption detected with XMM data only on two sources. Multi-wavelength analysis reveals **five Compton-thick sources**.
- Estimating the AGN contribution is hard with X-ray observations only.
- This results in detail will be **publish** in **A. Ruiz et al. 2006** (in preparation).