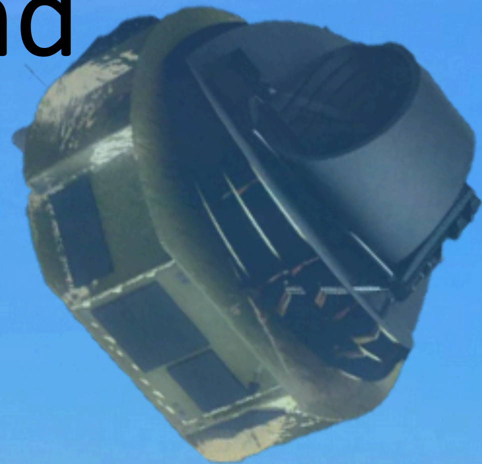
ARIEL School, 2019 and beyond



Jean-Philippe Beaulieu, Angelos Tsiaras, Ingo Waldmann,

Benjamin Charnay, Olivia Venot, Pierre Drossart, Jeremy Leconte.

Objective :

- Preparing the PhD students and postdocs to the science exploitation of ARIEL
- 20 participants max.
- 1 week workshop on specific science goals
- Hands on work by teams of 2-3 students
  - Different countries, different level of expertise
  - Access to one cluster with multicores
- Tutoring by senior scientists, and experienced students

- Working together, learning by hand—on work.

- Learning more by doing it yourself with real data and top end codes, with the proper tutorship.

- Everybody on the same location, so it is intense work for a week.

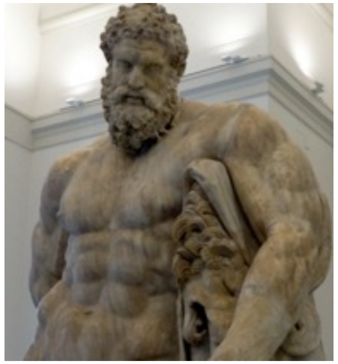
- Meeting colleagues and working with them.

- At the end of the school, students can download data from HST archive and can reduce the data with Iraclis, and model them with TauREX.

- Final stage, after the school, converting the analysis in a paper (that requires more than a week…)

4 Ingredients

HST Archives



IRACLIS code

Tsiaras et al.

TauREX code

Waldmann,
Rocchetto,
Al Refaie et al

Computing power

And 20 enthusiastic participants to the school

Indeed, enthusiastic…

2019, ARES:
Ariel Retrevial of exoplanet atmosphere School

Friday 27 september	Arrival at 18:00, diner
Saturday 28	**Exoplanet atmospheres** 09:00-10:30 : Introduction, radiative transfer, physics of the atmosphere in 1D, thermal structure, observations (Benjamin Charnay) 10:45-12:15 : Part II (Benjamin Charnay) 12:30 : lunch 14:00-15:30: Molecular spectroscopy, molecular lines and bands, their origin, chemistry of the planet atmospheres. (Olivia Venot) 15:45-17:15 : Part II (Olivia Venot) 19:15 : short presentations of each participant I 20:15 : diner
Sunday 29	**Solar system planets and exoplanet atmospheres** 09:00-10:30 : Solar system. History of the solar system observations to put today's exoplanet obs in perspective. Comets, disks (Pierre Drossart) 10:45-12:15 part II, references (Pierre Drossart) 12:30 :lunch Free afternoon 19:15 : short presentations of each participant II 20:15 : diner

Monday 30

HST data-processing
09:00-10:30 : Data processing I (Angelos Tsiaras)
12:30 :lunch
14:00-17:15 : Data processing II (Angelos Tsiaras)
19:15 : Atmosphere dynamics (Jeremy Leconte)
20:15 : diner

Tuesday 1

HST data processing (Angelos Tsiaras)
09:00-10:30 : Data processing III (Angelos Tsiaras)
12:30 :lunch
14:00-17:15 : Data processing IV (Angelos Tsiaras)
19:15 : 3D simulations & Direct imaging (Jeremy Leconte)
20:15 : diner

Wednesday 2

Introduction, atmosphere retrieval, TauREX (morning)
09:00-12:15 : Atmosphere Retrieval (Ingo Waldmann)
14:00-17:15 : TauREX handson I (Ingo Waldman, Quentin Changeat, Ahmed Al-Refaie)
19:15 : A non singular *quantum* universe (Patrick Peter)
20:15 : diner

Thursday 3

TauREX day
09:00-12:15 : TauREX handson II
14:00-17:15 : TauREX handson III
(Ingo Waldmann Quentin Changeat, Ahmed Al-Refaie)
20:15 : diner

Friday 4

Data Processing/ Tau Rex / literature
(Angelos Tsiaras, Ingo Waldmann, Quentin Changeat, Ahmed Al-Refaie)
20:15 : diner

Saturday 5

Presentation of results (afternoon) and compared to others.


LES AZALEES
1 à 2
DONT WASTE YOUR LIFE MAKE YOUR OWN CHOICES

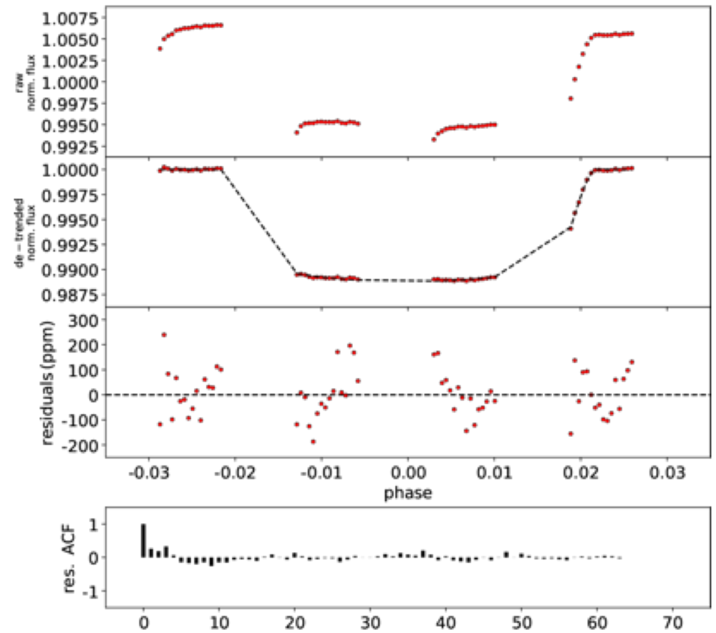
Friday, 18:00, end of classes.

ARES I: CHARACTERISING HOT JUPITERS WASP-127 B, WASP-79 B AND WASP-62 B WITH HUBBLE WFC3 TRANSMISSION SPECTRA*

Nour Skaf,[1,2] Michelle Fabienne Bieger,[3] Billy Edwards,[2] Quentin Changeat,[2] Mario Morvan,[2] Flavien Kiefer,[4] Doriann Blain,[1] Tiziano Zingales,[5] Mathilde Poveda,[6,7] Ahmed Al-Refaie,[2] Robin Baeyens,[8] Amélie Gressier,[4,1,9] Gloria Giulluy,[10,11] Adam Yassin Jaziri,[5] Darius Modirrousta-Galian,[11] Lorenzo Mugnai,[12] William Pluriel,[5] Niall Whiteford,[13] Sam Wright,[2] Benjamin Charnay,[1] Angelos Tsiaras,[2] Ingo Waldmann,[2] and Jean-Philippe Beaulieu[14,4]

Table 1. Target Parameters

Parameter	WASP-127b	WASP-79b	WASP-62b
Stellar parameters			
Spectral type	G5	F5	F7
$T_{\rm eff}$ (K)	5750	6600	6230
$\log g$ (cgs)	3.9	4.06	4.45
[Fe/H]	-0.18	0.03	0.04
Planetary parameters			
P (d)	4.17807015	3.662387	4.411953
$T_{\rm mid}$ (BJD−2450000)	8138.670144	7815.89868	5855.39195
I_c (°)	87.88	83.3	88.3
$M_{\rm P}(M_J)$	0.18	0.9	0.57
$R_{\rm P}(R_J)$	1.37	2.09	1.39
$T_{{\rm eq},A=0}$	1400	1900	1440
Derived parameters used for the Iraclis runs			
$R_{\rm P}/R_\star$	0.09992	0.112606	0.1091
$a_{\rm pl}/R_\star$	7.846	6.069	9.5253



See poster, Skaf et al.

Table 4. Comparison of the Bayesian log evidence for different models. For WASP-79b and WASP-62b, the retrieved temperature is always significantly below the equilibrium temperature for the planet, particularly if FeH is not included as an opacity source.

WASP-127b (No Molecules Log Evidence: 1.73)			
Setup	Log Evidence	Retrieved Temperature [K]	Equilibrium Temperature [K]
H_2O	161.87	1027	~1400
H_2O, CH_4, CO, CO_2, NH3	161.27	1005	
H_2O, FeH	170.20	1305	
H_2O, CH_4, CO, CO_2, NH3, FeH	169.64	1304	
WASP-79 (No Molecules Log Evidence: 173.53)			
Setup	Log Evidence	Retrieved Temperature [K]	Equilibrium Temperature [K]
H_2O	188.34	621	~1800
H_2O, CH_4, CO, CO_2, NH3	187.98	603	
H_2O, FeH	190.87	888	
H_2O, CH_4, CO, CO_2, NH3, FeH	190.60	924	
WASP-62 (No Molecules Log Evidence: 184.49)			
Setup	Log Evidence	Retrieved Temperature [K]	Equilibrium Temperature [K]
H_2O	191.65	607	~1450
H_2O, CH_4, CO, CO_2, NH3	190.92	597	
H_2O, FeH	193.40	842	
H_2O, CH_4, CO, CO_2, NH3, FeH	193.11	894	

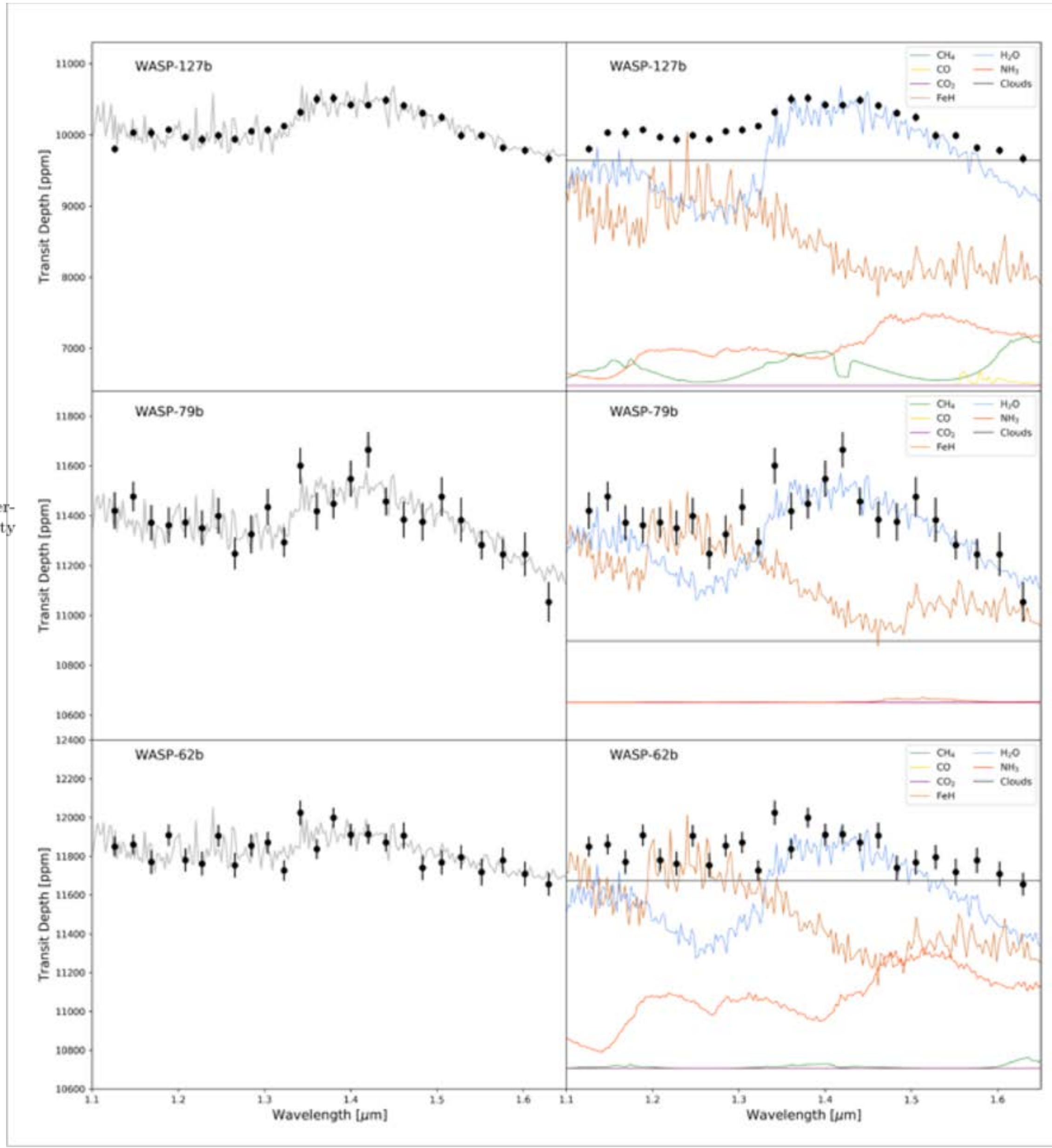
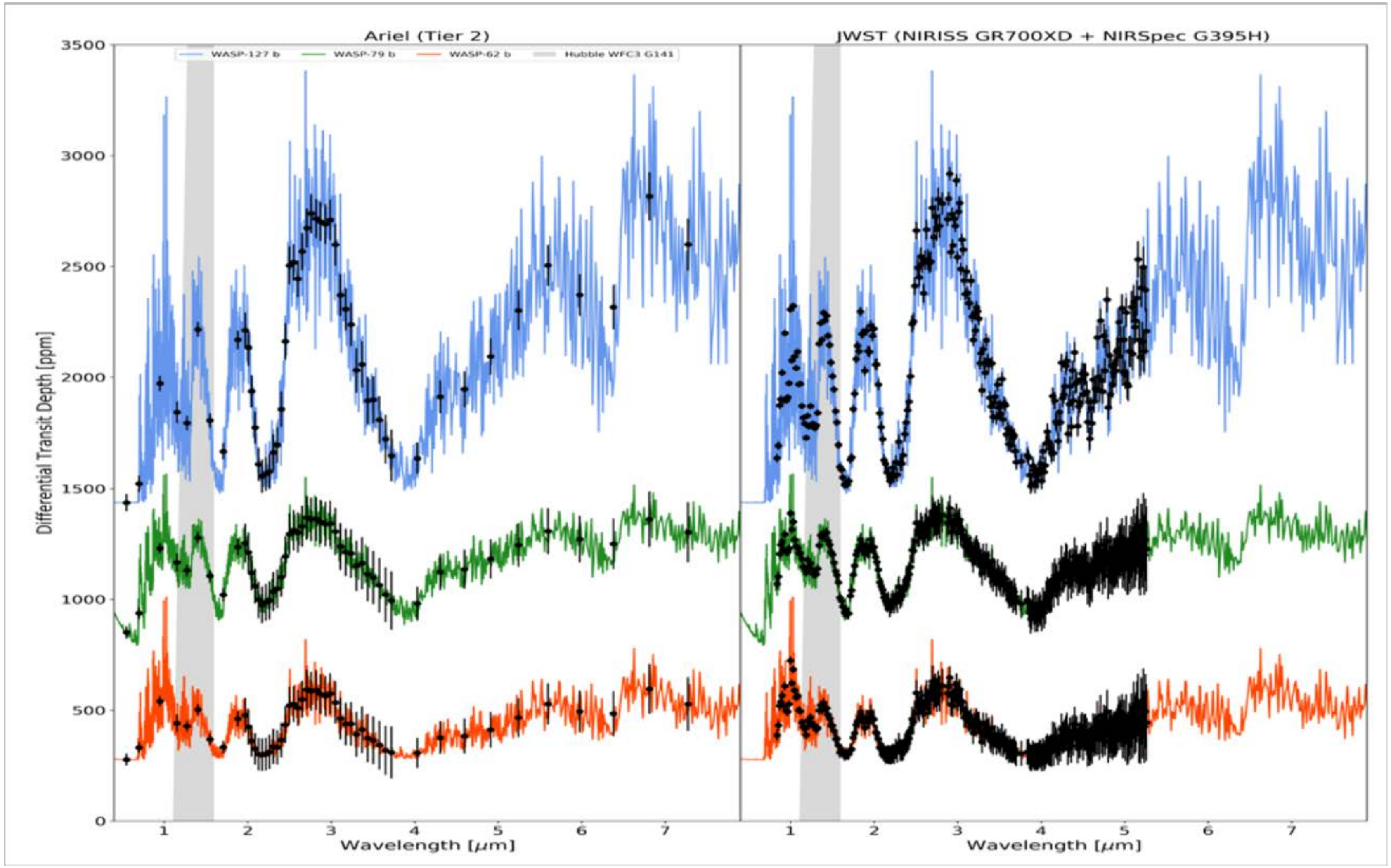


Table 3. Table of fitted parameters for the retrievals performed on our targets

Retrieved Parameters	bounds	**WASP-127b**	**WASP-79b**	**WASP-62b**
$\log[H_2O]$	1e-12 - 1e-1	$-2.71^{+0.78}_{-1.05}$	$-2.34^{+0.51}_{-0.72}$	$-2.56^{+0.76}_{-1.17}$
$\log[FeH]$	1e-12 - 1e-1	$-5.25^{+0.88}_{-1.10}$	$-4.39^{+0.88}_{-1.12}$	$-4.10^{+1.26}_{-1.82}$
$\log[CH_4]$	1e-12 - 1e-1	< -5	< -5	< -5
$\log[CO]$	1e-12 - 1e-1	< -3	< -3	< -3
$\log[CO_2]$	1e-12 - 1e-1	< -3	< -3	< -3
$\log[NH3]$	1e-12 - 1e-1	< -5	< -5	< -5
T_p (K)	400-2500	1304^{+185}_{-175}	924^{+242}_{-204}	894^{+248}_{-239}
R_p (R_{jup})	$\pm$ 50%	$1.15^{+0.04}_{-0.04}$	$1.69^{+0.02}_{-0.02}$	$1.34^{+0.02}_{-0.02}$
$\log P_{clouds}$	1e-2 - 1e6	$1.7^{+0.93}_{-0.66}$	> 3	$2.5^{+1.1}_{-0.88}$
μ (derived)		$2.34^{+0.20}_{-0.03}$	$2.38^{+0.33}_{-0.07}$	$2.46^{+0.32}_{-0.04}$
ADI	-	167.9	17.1	8.6
σ-level	-	$> 5\sigma$	$> 5\sigma$	$3 - 5\sigma$

What will JWST and ARIEL observe for these 3 planets ?



Next ARIEL Schools.

- Training now the young scientists on exoplanet atmosphere retrieval, and the ARIEL Science.
- Every year, or 2 years, TBD
- Currently, support from CNES alone, other partners willing to join ?
- ARES II : Dates October 3-11, 2020, in Biarritz, France
- 20 students, 5 tutors
- Really hands—on, meaning we cannot grow to 40+ participants.
- Topic, TBD within few weeks

Retrieval, stellar activity, machine learning techniques, JWST, Direct Detection, solar system, Dynamic, Chemistry… lots of fun things to do