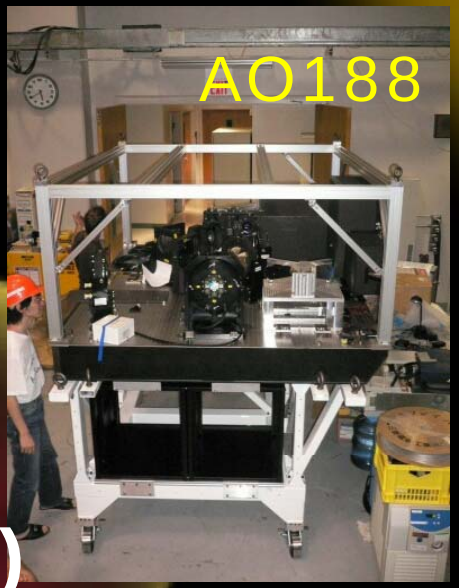
SEEDS

Strategic Explorations of Exoplanets and Disks with Subaru

本ファイルでは未発表データを省いてあります



2011.9.7 9:40-10:00
@ Kyoto Univ.

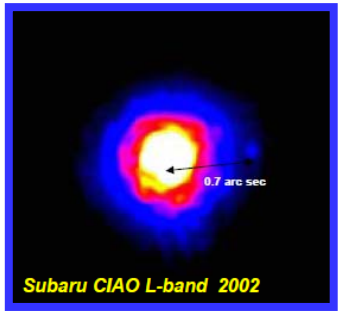
M. Tamura
on behalf of
the HiCIAO/AO &
SEEDS team (~110 member)

今日の話の内容

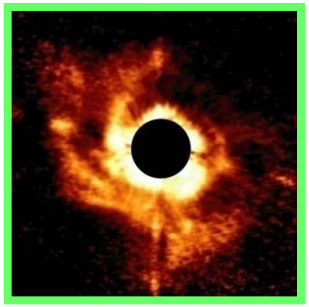
- イントロ：系外惑星観測のまとめ
- SEEDSとは？
- 歴史
- 現状
- マネジメント
- まとめ

SEEDS – Strategic Exploration of Exoplanets and Disks with Subaru

- First “Subaru Strategic Program (SSP)” – a new open-use category
- 120 Subaru nights in 5 years
- Direct imaging and census of giant planets in the outer regions (a few - 40 AU) around ~500 solar-type and massive stars
- Exploring protoplanetary disks and debris disks for the origin of their diversity and evolution at the same radial regions
- Direct linking between planets and protoplanetary disks



>100AU scale w/ CIAO



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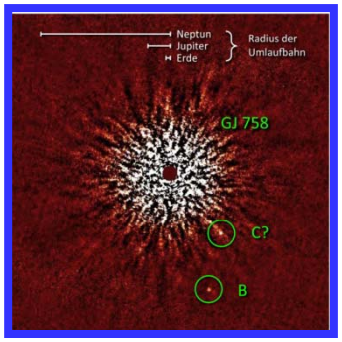


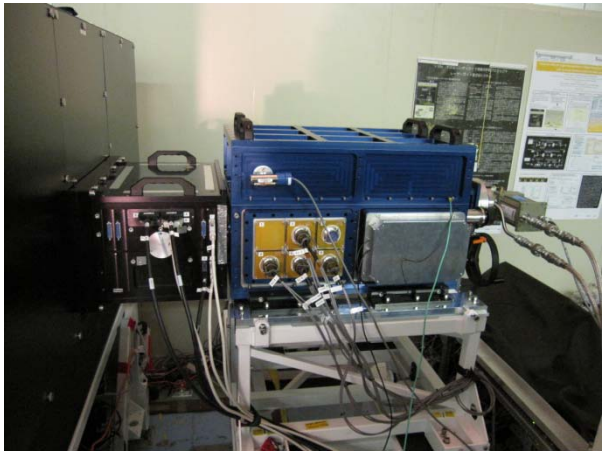
Solar-System Scale (<50AU) w/ **HiCIAO**

disk data shown later

Subaru/HiCIAO+AO188+SCExAO

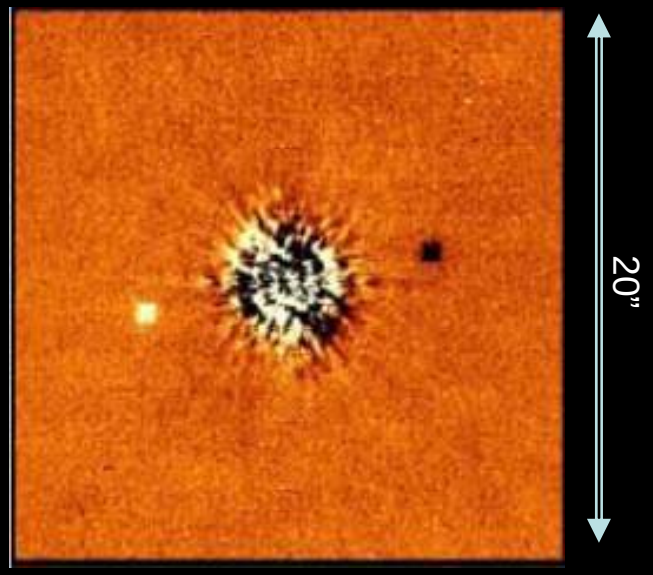
- HiCIAO: High Contrast Instrument for the next generation Adaptive Optics
  - For Subaru 8.2m telescope
  - PI & CoPIs: Motohide Tamura (NAOJ), Klaus Hodapp (UH), Ryuji Suzuki (NAOJ)
  - Based on a previous Japan/MEXT grant (~100%)
- Combined with the curvature-sensing AO with 188 elements (Hayano, Takami et al.) and SCExAO1024 upgrade (Guyon, Martinache)
- Commissioned mainly in 2009 with AO188

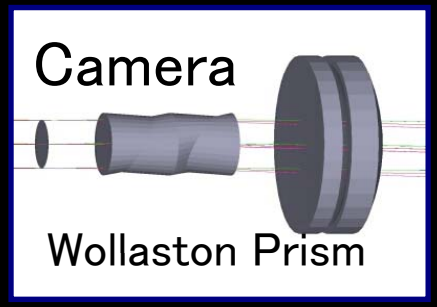
- Specification and Performance
  - 2048x2048 HgCdTe detector and ASIC readout
  - Wavelengths: 1 – 2.5 microns (NIR)
  - Observing modes: DI, PDI (dual beam), SDI (quad beam), & ADI; w/wo occulting masks (>=0.1"ϕ); 10mas/pixel
  - Contrasts on-sky: 10^-6 at 1", 10^-4 at 0.15"
    - Roughly 10 times better than CIAO, as specified
  - New features constantly introduced (4ch polarimetry, window-mode ASIC readout)



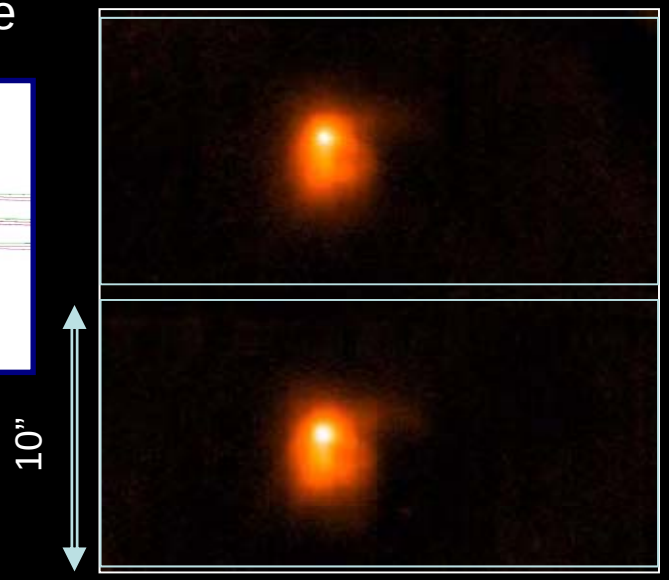
Four observation modes of HiCIAO: DI, PDI, SDI, ADI

Direct Imaging (DI) mode

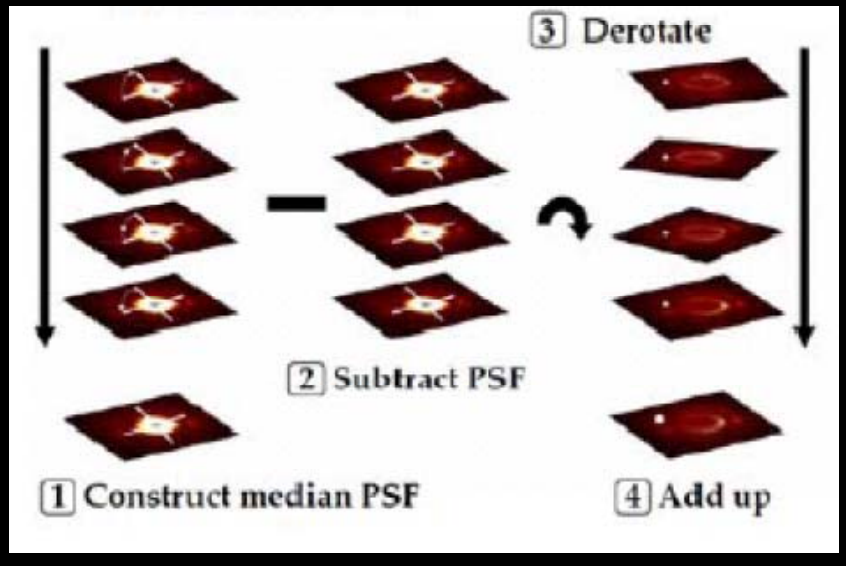




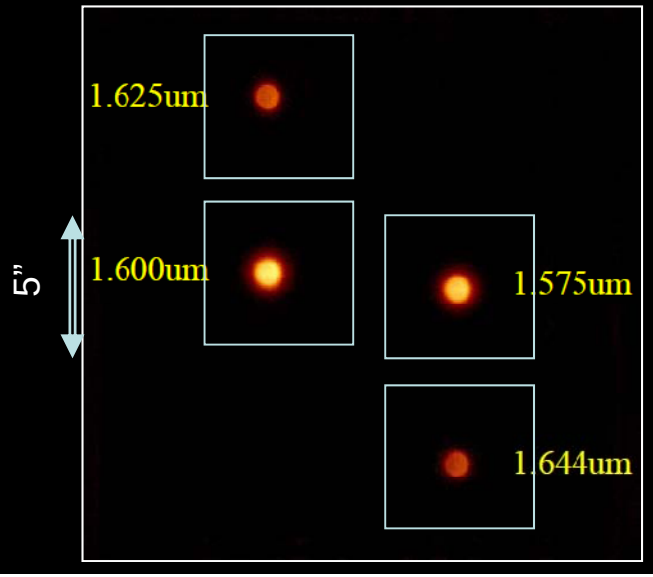
Polarization Differential Imaging (PDI) mode



Angular Differential Imaging (ADI) mode



Spectral Differential Imaging (SDI) mode



SEEDS Short History

(2004)	Sep	HiCIAO project officially started (MEXT Tokutei fund)		
(2007)	Mar 27	SSP Call for Proposal issued		
	Jul 31	Application submitted to Subaru (Two proposals)		
	Aug 8	SEEDS got through the first screening		
	Nov 14	Hearing by the TAC & (other?) referees		
	Dec 3	HiCIAO Telescope First Light without AO188		
(2008)	Feb 1	First SEEDS workshop		
	Feb 12	Reply to SAC on SEEDS "team formation" and each role		
	Mar 28	SEEDS proposal accepted by SAC & TAC (PV required)		
	Mar-Sep	Extensive target re-selection in each category started		
	Sep 3-4	SEEDS all-category meeting (Mitaka)		
	Dec 21	HiCIAO Telescope First Light coupled with AO188		
(2009)	Jan 17	SEEDS all-category meeting (Mitaka)		
	Mar 9-12	Kona international workshop		
	Oct 1	Performance Verification passed		
	Oct 30-Nov 1	3	2 clear	1st SEEDS run
	Dec 22-25	4	4	2nd SEEDS run
(2010)	Jan 22-24	3	3	3rd SEEDS run
	(Feb, Apr, Jun	allocated but cancelled due to AO-DM trouble!)		
	Nov 30-Dec 2	3	2	4th SEEDS run
	Dec 25-28	4	0	5th SEEDS run
(2011)	Jan 27-31	5	3	6th SEEDS run
	Mar 24-27	4	2	7th SEEDS run
	May 20-25	6	5	8th SEEDS run
	(July	allocated but canceled due to telescope coolant trouble)		
	Aug	2.5	1.5	9th SEEDS run
		34.5	22.5 (65% clear)	
(2014)		To be end of the SEEDS Survey		

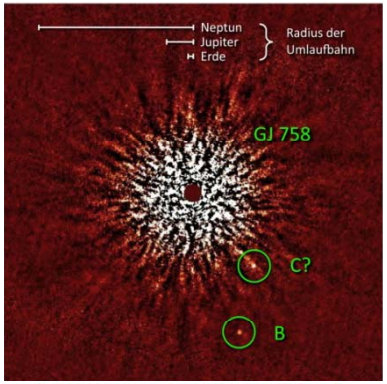
SEEDS Target/Observation Summary

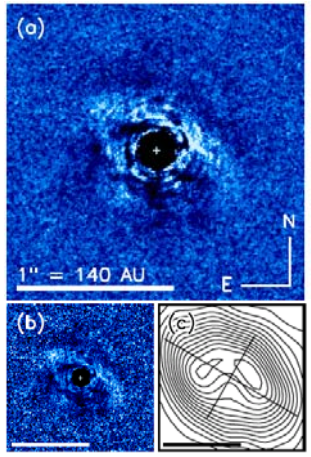
Category	Planet searches			Disk searches		Total number
	(a)	(b)	(c)	(d)	(e)	
	SFR YSOs	Open cluster & Moving Group	Nearby stars & WDs	Protoplanetary disks	Debris disks	
Target #	210*	60+40	140*+37	Same targets as (a)	70	557 Target balance can change
Distance	~140 pc	<~125 pc	<~30 pc	~140 pc	<~130 pc	
Age	1-10 Myr	10~100 Myr	100 Myr - 1 Gyr	1-10 Myr	5 Myr - 6 Gyr	
Observed Incl. Fup	30	16+32	69+1	Same targets as (a)	30	178 Including multiple observations
Refereed Publications	LkCa15, AB Aur		HAT-P-7, GJ758-Im&Sp	Same as (a)	(HR4796A)	5+(1)
Drafts in prep.	UX Tau, RY Tau, AB Aur(JK), LkCa15 FU, MWC480, TW Hya, SAO206462	One-Yr paper each	One-Yr paper	Same as (a)		~10

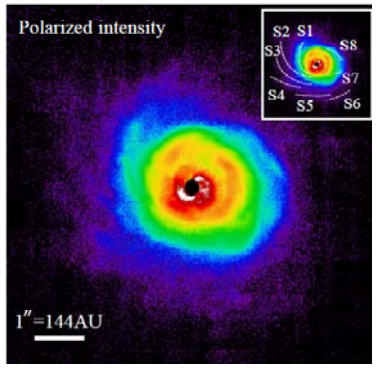
Note that we usually need one year interval for proper motion tests.
But early results from the 2009 runs have already been published.
So far, 5 papers published, 1 submitted, ~10 drafts in prep.

Summary of Early Results

- Direct imaging of planet candidates around an old G-type star GJ758, (commissiong)
  Thalmann et al. 2009, ApJL, 707, 123.
  記者会見1
- Search for outer massive bodies around transiting planetary systems: Candidates of faint stellar companions around HAT-P-7,
  Narita et al. 2010, PASJ, 62, 779
- Imaging of a transitional disk gap in reflected light: Indications of planet formation around the young solar analog LkCa 15,
  Thalmann et al. 2010, ApJL, 718, L87.
  記者会見2
- Near-infrared multi-band photometry of the substellar companion GJ 758b,
  Janson et al. 2011, ApJ, 728, 85.
- Direct imaging of fine structures in giant planet forming regions of a protoplanetary disk around AB Aur,
  Hashimoto et al. 2011, ApJL, 729, L17.
  記者会見2





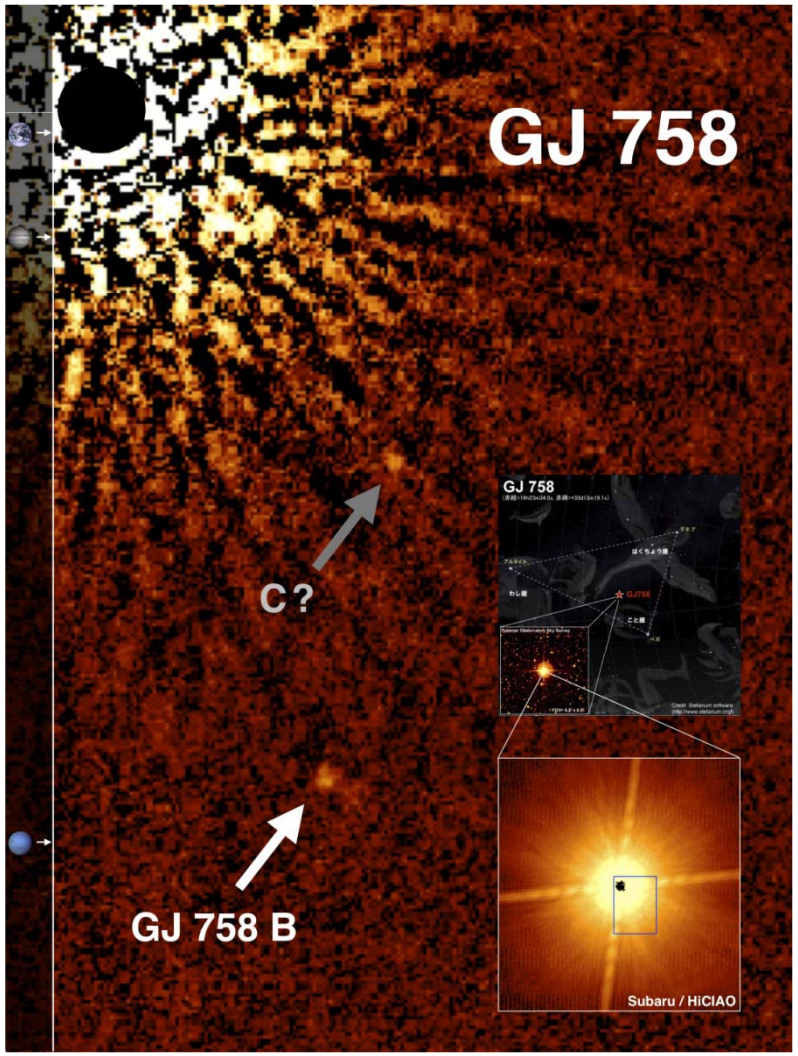


Direct Imaging of Planet Candidates around a G Star GJ 758

- GJ 758 A: G9 Type star
  - V=6; Mass=0.97Mo
- Distance: 16pc
- Age
  - Isochrone estimate: 700Myr (Takeda et al. 2007; isochrone)
- GJ 758 b
  - Common proper motion
  - Possible orbital motion
  - 10-30$M_{Jupiter}$ (age uncertainty)

- Follow-up with Keck, Gemini
  - Narrow-band spectroscopic confirmation
  - Methane feature
  - Janson et al. 2011

GJ758=HD182488=HIP95319

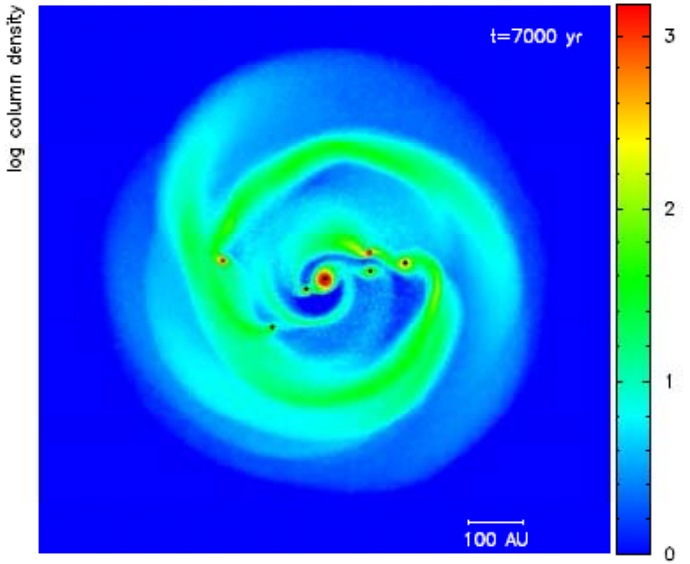


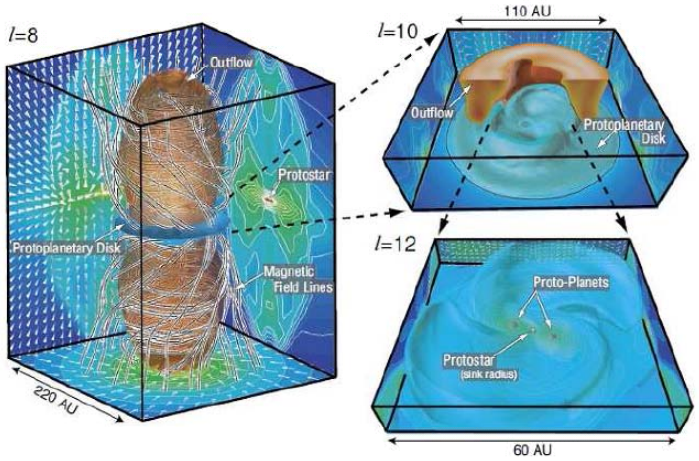
1.6 micron image with ADI

Thalmann et al. 2009

Constraint for planet formation theory

- Core accretion model (standard)
  - Formation times scale problem for outer planets
  - <~10 AU maybe OK
  - HR8799, GJ758B are too far
  - Migration to 100AU or far needs to be studied
- Gravitationally instability
  - Better for outer giant planets
  - Such a massive disk is hypothetical
- Planet outer migration?
- Planet scattering among multiple planets
- Should be considered as part of star formation (Machida+2010)

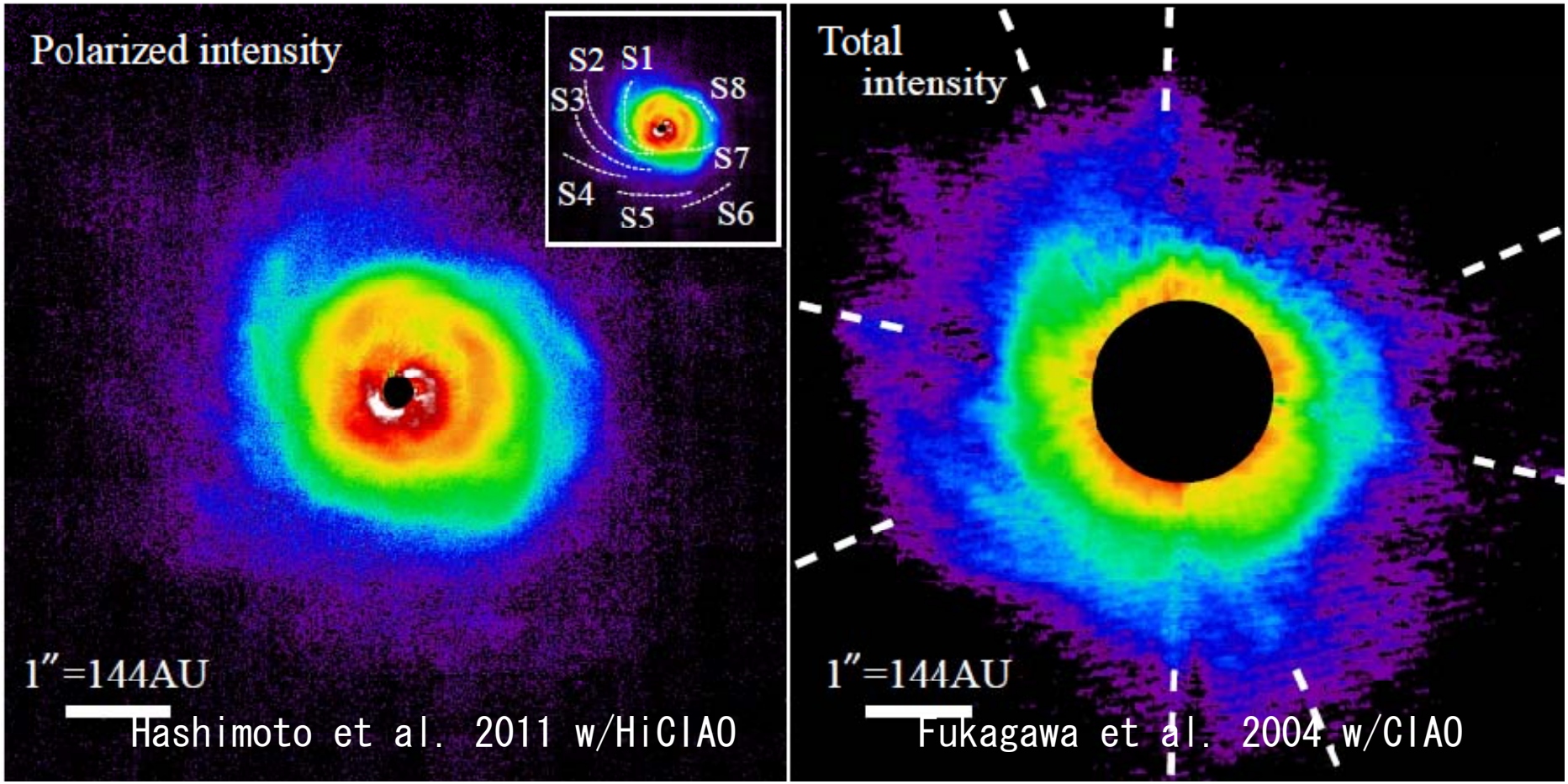




We hope to study their initial conditions (disks), too !

Sharpest and closest image of AB Aur Disk

- AB Aur: Herbig Ae star, age=4Myr, mass=2.4Mo, distance=144pc
- The first r<40 AU & 8 AU resolution images (1.6um)
- PI image, but not POL pattern but mostly INTENSITY pattern (see Figure)
- Hashimoto, Tamura, Muto et al. 2011



How to manage the SEEDS project

- Instrument operation & maintenance by ESP project office and developers
  - TARGET proposed by each category
  - OBS conducted by expert team
  - RED/PUB by LOI persons
- The "Rule" book + core
  - Rights and duties
  - Membership, Observations, Data, Publications, Follow-ups
- Letter of Intent system
- Regular all-category meetings (monthly)
- Each-category meetings/ML
  - YSO, OC, NS, DD, MG, WD
  - weekly to monthly, depending on each category
- Yearly workshop hosted by member foreign institutes
- Data reduction workshop
  - LOCI, PDI, Modeling

Memorandum: Rules for SEEDS collaborations Ver. 3.0

M. Tamura

2008.5.9; 2009.11.2, 11.21, 11.30, 12.1, 12.25; 2010.2.16, 6.1

This document describes the general rules on the SEEDS collaborations. This version is not for complete agreement but rather for agreeing general policy on rules and making necessary items.

I. SEEDS Membership

1. New Japanese collaborators

A) SEEDS (Strategic Explorations of Exoplanets and Disks with Subaru) is the Strategic Observations project that encourages collaborations, in particular among Japanese researchers. Therefore, new Japanese members are welcome even after the start of the SEEDS observations. If the SEEDS PI is contacted by a Japanese researcher, the PI will report it to the core member (currently the SEEDS proposal core composed of the instrument and observatory key persons) for permission.

2. Membership of students (both Japanese and international)

Students are not permanent and new students might join the SEEDS project at any time. Therefore, different rules are necessary.

A) New students can join the SEEDS project if they have appropriate supervisor(s). The student supervisor should contact with the SEEDS PI for permission.

B) If there is no appropriate supervisor, the student can contact with the SEEDS PI.

C) The students moving to new positions can keep the SEEDS membership, if they wish.

3. New foreign collaborators

A) Institutional-partnership foreign collaborators (currently Princeton with MOU, and MPIA planning to make MOU with NAOJ eventually) are regarded as the Japanese collaborators that do not always make MOU with NAOJ. They basically have the same duty and right with the Japanese member.

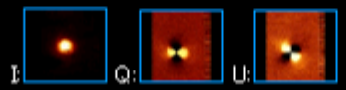
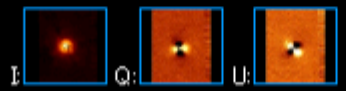
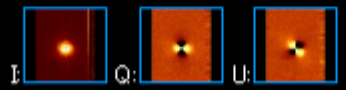
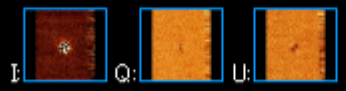
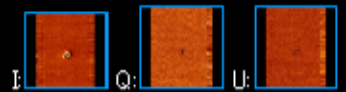
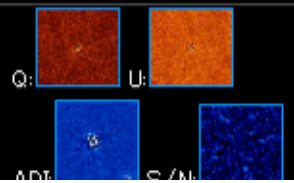
B) Other new foreign collaborators are not based on institutional-partnership but rather are individual researcher-based. In this case, each member should

SEEDS Quick Look and data Request

If you're interested in a particular object(s), FIRST, please send your Letter of Intention to the PI as a potentially responsible person for the subsequent data reduction and analysis, and paperwriting. (See the SEEDS Rule Book draft for the procedure.)

Categorys: Young Stellar Objects, Open Clusters, Moving Groups, Debris Disks, Nearby Stars

Young Stellar Object

	Thumbnail	Object Name	Obs. date (HST)	mode/band	Exp. time	LoI
1. ☐		AB Aur	2009 Oct. 30	PDI / H	20 min	J. Hashimoto, M. Fukagawa Y. Okamoto C. Grady K. Hodapp
2. ☐		AB Aur	2009 Oct. 31	PDI / J	20 min	M. Fukagawa Y. Okamoto J. Wisniewski C. Grady
3. ☐		AB Aur	2009 Oct. 31	PDI / K	8 min	M. Fukagawa Y. Okamoto C. Grady
4. ☐		DL Tau	2009 Nov. 1	PDI / H	22 min.	T. Kudo K. Hodapp J. Wisniewski Y. Itoh
5. ☐		[illegible]	[illegible]	[illegible]	32 min.	T. Kudo K. Hodapp J. Wisniewski Y. Itoh
6. ☐		N Tau	2009 Dec. 22	PDI+ADI / H	12 min.	K. Hodapp J. Wisniewski Y. Itoh

Quick Look を作成し、SEEDSプロジェクトメンバーへWeb上で公開

このページから生データのリクエストを行なう

Summary

- First Subaru Strategic Program “SEEDS” explores direct imaging for exoplanet and their formation studies that are crucial for detecting wide orbit planets and subsequent studying their properties such as atmospheres and planet origin.
- In spite of several troubles on TEL/AO, the project proceeds smoothly and the results are highly rated.
- Some 110 people including 30% international member are now involved in SEEDS (management/strategy).
- Early results on planet candidates and protoplanetary disk fine structures are presented.
  - GJ758, HAT-P-7: SUGGESTION OF OUTER PLANETS
  - AB Aur, LkCa15, HR4796A: DISK SIGNPOST OF PLANETS
- Please stay tuned for coming exciting results!
- Currently supported by Specially Promoted Research.