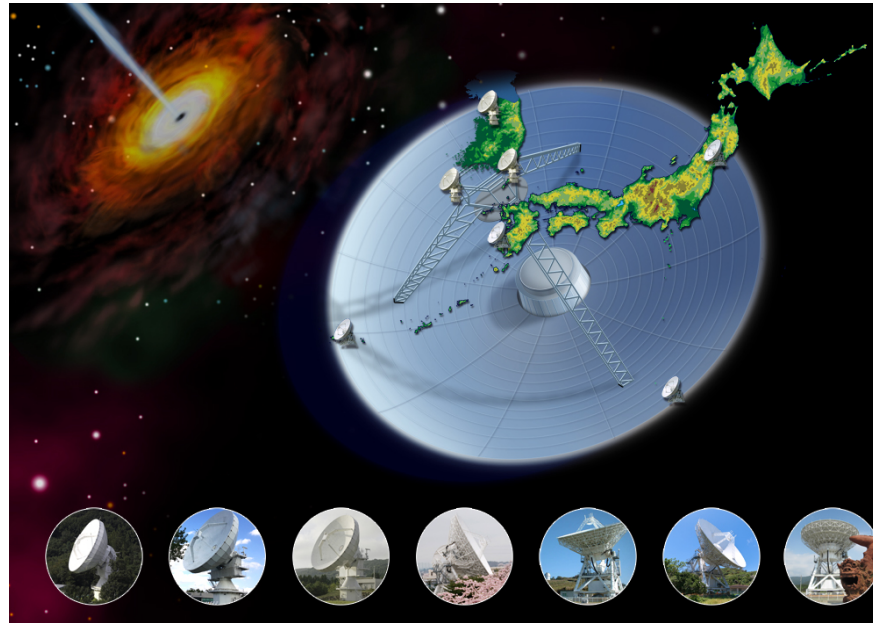
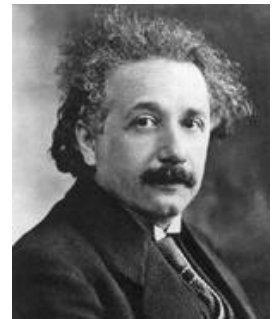
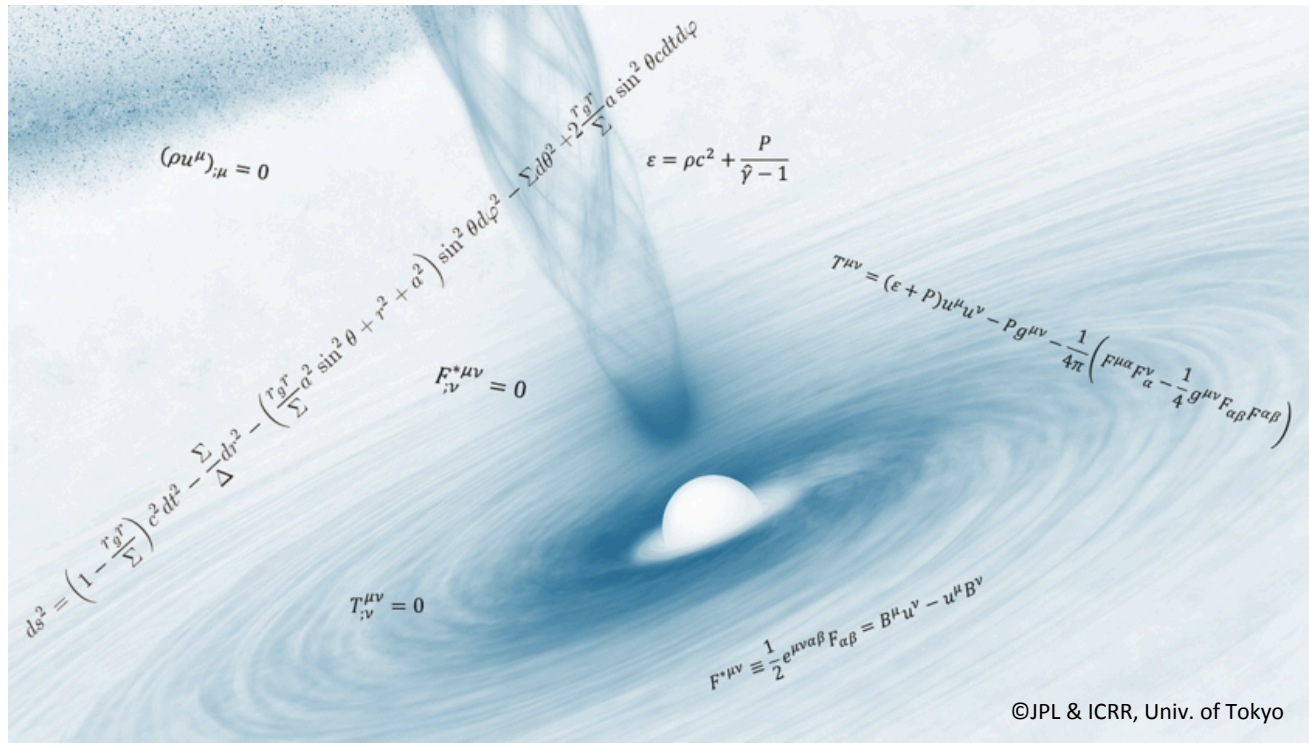


Highlight of KaVA AGN Large Program



M. Kino (KASI/NAOJ)
on behalf of KaVA AGN Science-WG

How does BH powers jet?



This is one of the longstanding problems in modern astrophysics.

Approved in January 2016!

Exploring the vicinity of super-massive black hole with KaVA: Intensive monitoring of M87 and Sgr A*

*M. Kino (KASI), B.W. Sohn (KASI) and KaVA AGN Sub Working Group**
(* The member list is attached in the last page.)

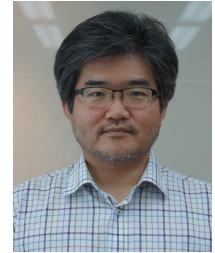
Abstract

Exploring the vicinity of super-massive black holes (SMBHs) is one of the frontiers in astrophysics. Because of the largeness of angular-sizes of the central SMBHs, Sagittarius A* (Sgr A*) is the excellent laboratory for studying gas accretion process onto SMBH and M87 is well known as the best case for investigating plasma outflow ultimately driven by SMBH. To get better understanding of plasma inflow/outflow physics near SMBHs, here we propose the monitoring programs of Sgr A* and M87. This program is composed of following three sub-programs, i.e., (i) mapping the jet velocity field in M87 and constraining magnetically-driven-jet paradigm, and (ii) probing the nature accreting plasma onto SMBH by monitoring Sgr A*, and (iii) conducting quasi-simultaneous coherent observations of M87 and Sgr A* with the Event Horizon Telescope (EHT) during its campaign observation periods.

Yes, we are ready to go LP!

- PIs: M. Kino & B.W. Sohn (KASI)

KaVA AGN SWG member list (2016 April)



=====			=====		
core			non-core		
=====			=====		
Motoki Kino	(KASI)	PI of AGN	Jeffrey Hodgson	(KASI)	
Bong Won Sohn	(KASI)	PI of AGN	Se-Jin Oh	(KASI)	
Juan-Carlos Algaba	(KASI)		Minsun Kim	(KASI)	
Fumie Tazaki	(NAOJ)		Sang-Sung Lee	(KASI)	
Guang-Yao Zhao	(KASI)		Jan Wagner	(KASI)	
Kazuhiro Hada	(NAOJ)		Jee Won Lee	(KASI)	student
Kazunori Akiyama	(MIT)		Sincheol Kang	(KASI)	student
Mareki Honma	(NAOJ)	Director	Wu JIANG	(SHAO)	
Kotaro Niinuma	(Yamaguchi U)		Hiroshi Imai	(Kagoshima U)	PI of ES
Sascha Trippe	(SNU)		Gabor Orosz	(Kagoshima U)	student
Shoko Koyama	(MPIFR)		Cheulhong Min	(GUAS/NAOJ)	student
Taehyun Jung	(KASI)		Akihiro Doi	(ISAS/JAXA)	
Kiyooki Wajima	(KASI)		Tomoya Hirota	(NAOJ)	PI of SFR
Noriyuki Kawaguchi	(SHAO)		Yuanwei Wu	(NAOJ)	
Yoshiaki Hagiwara	(Toyo U)		Richard Dodson	(ICRAR)	
Satoko Sawada-Satoh	(Ibaraki U)		Maria Rioja	(ICRAR)	
Jong-Ho Park	(SNU)	student	Atsushi Miyazaki	(Hosei U)	
Junghwan Oh	(SNU)	student			
Taeseok Lee	(SNU)	student			
Hyemin Yoo	(Yonsei U)	student			
Yongjin Jeong	(Yonsei U)	student			
Hyunwook Ro	(Yonsei U)	student			
Ilje Cho	(KASI)	student			
Jeong Ae Lee	(KASI)	student			

VERA UM 2016

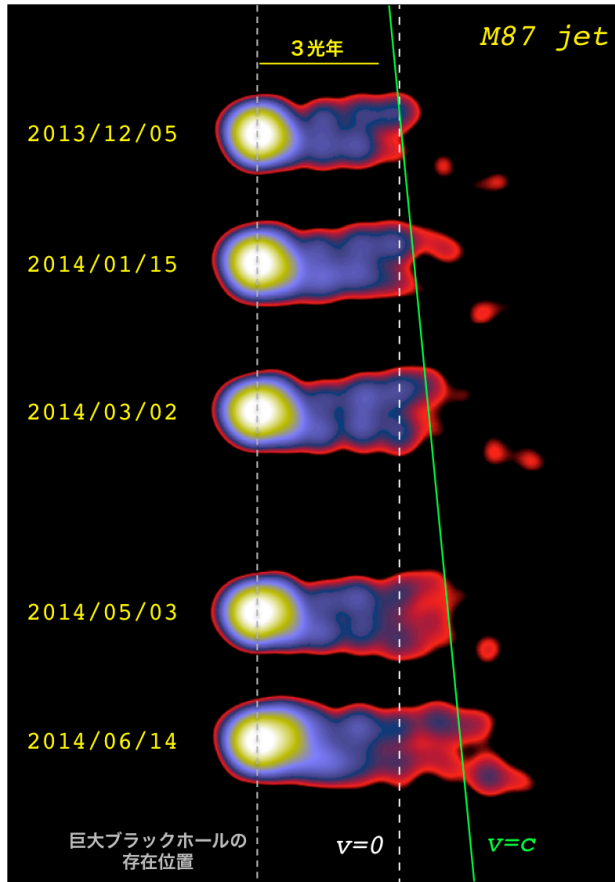
Mapping jet velocity field and testing B-driven jet paradigm

M87 (1 mas = 140 Rs) is the best source for this study.

例えば $3c$ の運動を検出するには、

- M87の距離では、 $1\text{mas}/\text{月} \sim 3c$ 。以下では、典型的なビームサイズ 1mas の場合を考える。
- 最低3エポックで同成分の運動検出を課すと、~2週間間隔 が要求される。
- 観測要求時間がかかなり長くなる。。。通常の観測提案でカバーすることは難しい。

Discovery of super-luminal motion! (pilot study in 2014)



2016年春季年会

日程：2016年3月14日（月）～17日（木）
場所：首都大学東京 南大沢キャンパス（東京都八王子市）

Hada-san with full smile!



Press release at ASJ
meeting on Mar 12th!

Pilot KaVA monitoring program of the M87 jet: confirming the inner jet structure and superluminal motions at sub-pc (or xxRs) scales

Kazuhiro Hada, Jong Ho Park, Motoki Kino, Kotaro Niinuma, Bong Won Sohn, Hyun Wook Ro, KaVA AGN Core, KaVA AGN fans, Others

¹Mizusawa VLBI Observatory, National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

²Department of Astronomical Science, The Graduate University for Advanced Studies (SOKENDAI), 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

Department of Physics and Astronomy, Seoul National University, Gwanak-gu, Seoul 08826, Republic of Korea

Korea Astronomy and Space Science Institute, Yuseong-gu, Daejeon 34055, Korea

Graduate School of Science and Engineering, Yamaguchi University, Yoshida 1677-1, Yamaguchi, Yamaguchi 753-8512, Japan

Department of Astronomy, Yonsei University, 134 Shinchondong, Seodaemun-gu, Seoul 120-749, Republic of Korea

Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, Bonn, 53121, Germany

Toyo University, 5-28-20 Hakusan, Bunkyo-ku, Tokyo 112-8606, Japan

Now we are writing a paper!

The PhD students are leading the M87 monitoring project from 2016!

	total epoch	Interval	when (duration)	1 epoch	total
M87 @22GHz	8 epochs	2 weeks	2016 March – June (4 months)	7hrs	56
M87 @43GHz	8 epochs	2 weeks	2016 March – June (4 months)	7hrs	56

M87 @ 43GHz

Jongho Park (Seoul Nat. Univ.)



M87 @ 22GHz

Hyunwook Ro (KASI)



M87 velocity-field in 2016!

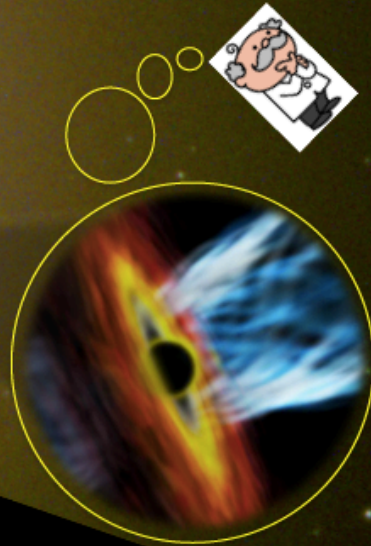
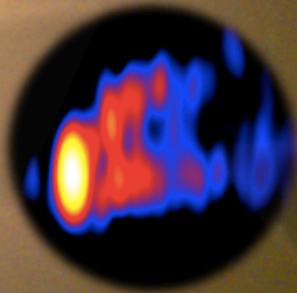
22/43 kinematics are well consistent!

JH Park' presentation in East Asia AGN workshop 2016

preliminary

ブラックホールジェット 小研究会

2016年9月29日(木)
東北大 天文専攻 大輪講室



13:00 - 13:15

当真 賢二 (東北大) 「はじめに」

13:15 - 14:15

秦 和弘 (国立天文台水沢VLBI観測所)

「超高解像度で電波撮像する巨大ブラックホールとジェット」

14:30 - 15:30

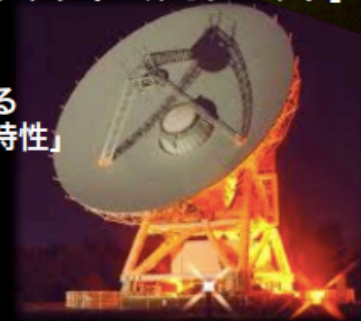
中村 雅徳 (台湾中央研究院)

「ブラックホールと銀河が共進化する
環境における相対論的ジェットの特性」

15:30 - 16:30

紀 基樹 (韓国天文宇宙科学研究院)

「理論と超高解像度電波観測で挑む
ブラックホールジェット形成の謎」



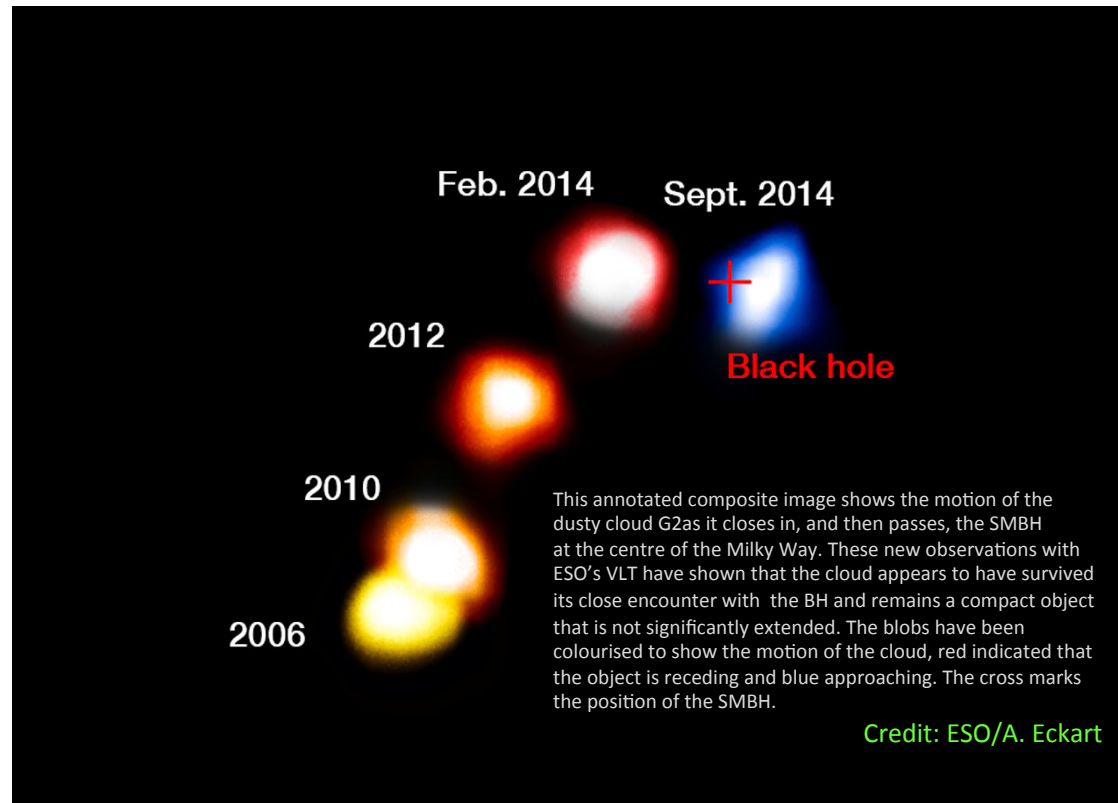
Kick-off of new
collaboration
with
theoretical group

VERA UM 2016

Probing real vicinity of SMBH and looking for G2-encounter imprint

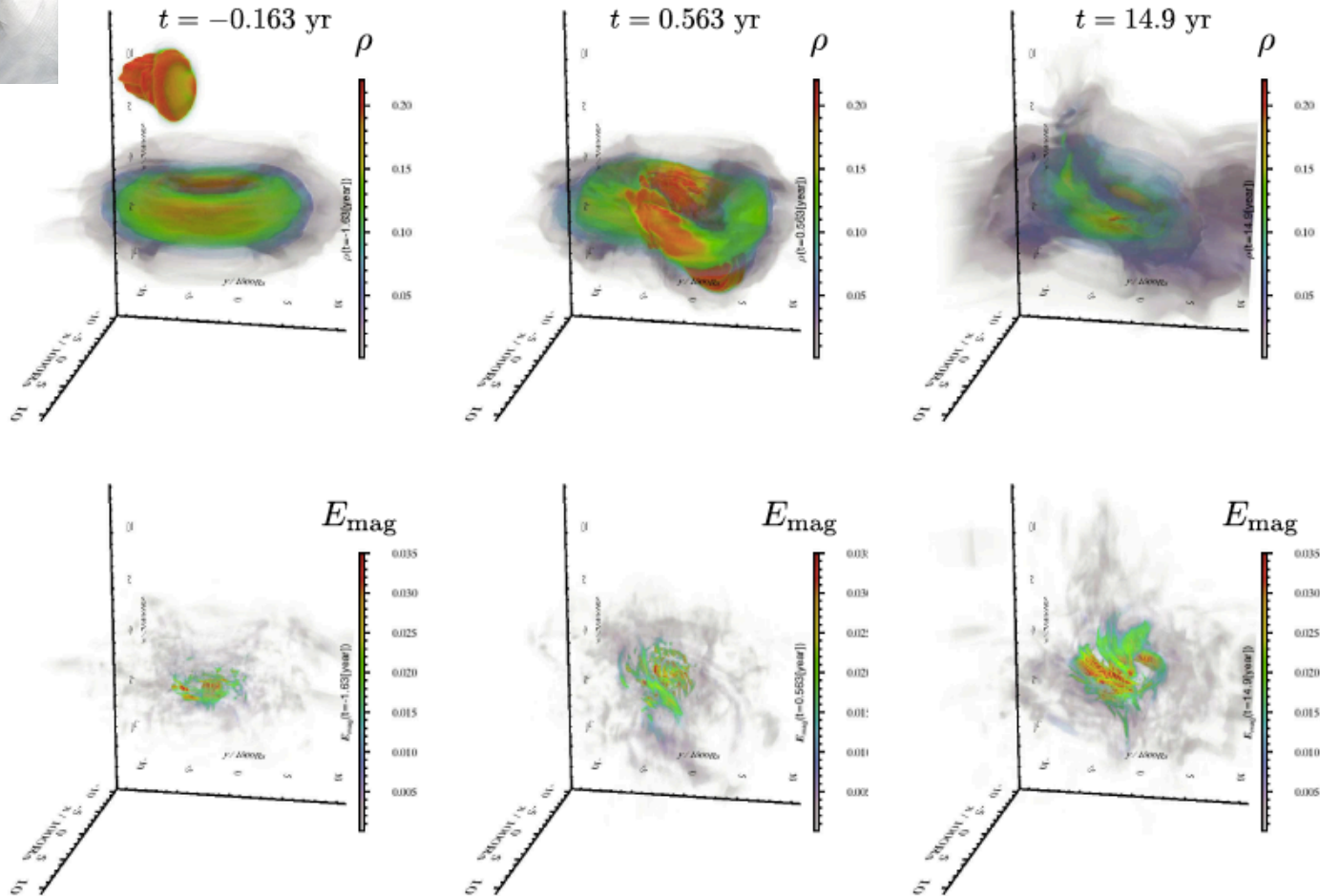
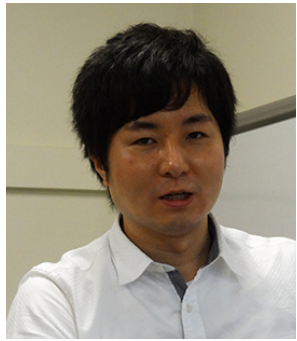
Sgr A* (1 mas = 100 Rs) is the unique source for this study.

Outstanding Question:



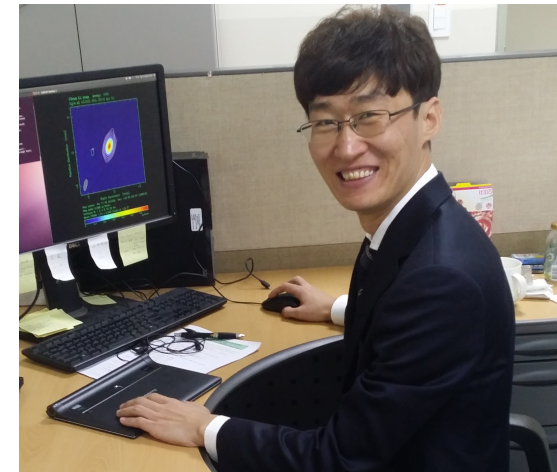
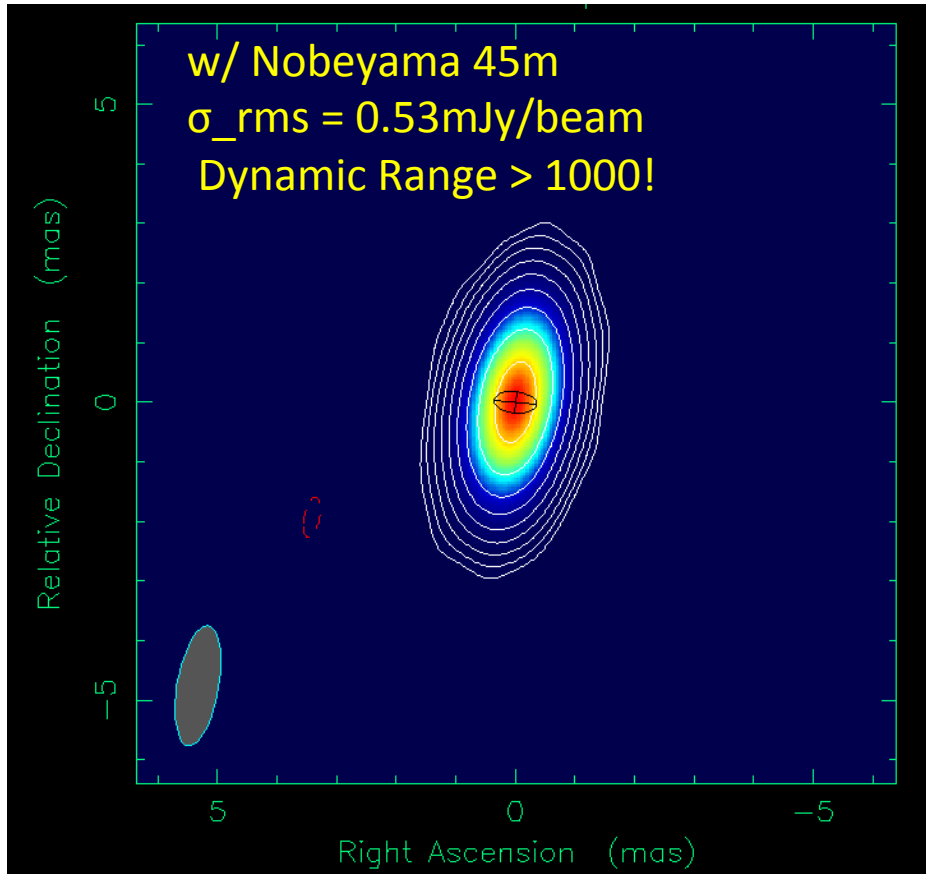
Imprint of G2 encounter is detectable?

Kawashima prediction: Disk-tilting & B-field enhancement by G2!



Testing Kawashima prediction w/ KaVA!
(The timescale of alpha-viscosity is a few years.)

Guangyao Zhao (KASI) is carefully dealing with Sgr A* data at 43GHz in 2014-15.



- On the way wrapping up the results.

invited talk by GY Zhao in IAU

proceedings submitted in Sep 2016

The Multi-messenger Astrophysics of the Galactic Center
Proceedings IAU Symposium No. 322, 2016
A.C. Editor, B.D. Editor & C.E. Editor, eds.

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DOI: 00.0000/X0000000000000000X

Millimeter VLBI observations of Sgr A* with KaVA and KVN

G.-Y. Zhao¹, M. Kino¹, I.-J. Cho^{1,2}, K. Akiyama^{3,4}, B. W. Sohn^{1,2}, T. Jung^{1,2}, J. C. Algaba¹, K. Hada⁴, Y. Hagiwara⁵, J. Hodgson¹, M. Honma⁴, N. Kawaguchi⁶, S. Koyama⁷, J. A. Lee^{1,2}, T. Lee⁸, K. Niinuma⁹, J. Oh⁸, J.-H. Park⁸, H. Ro^{1,10}, S. Sawada-Satoh¹¹, F. Tazaki⁴, S. Trippe⁸, K. Wajima¹, H. Yoo^{1,10}

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³ MIT, Haystack Observatory, Route 40, Westford, MA 01886, USA

⁴ National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

⁵ Toyo University, 5-28-20, Hakusan, Bunkyo-ku, Tokyo 112-8606, Japan

⁶ Shanghai Astronomical Observatory, CAS, 80 Nandan Road, Shanghai 200030, China

⁷ Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, Bonn, 53121, Germany

⁸ Seoul National University, Seoul 151-742, Korea

⁹ Yamaguchi University, Yoshida 1677-1, Yamaguchi, Yamaguchi 753-8512, Japan

¹⁰ Yonsei University, 134 Shinchondong, Seodaemungu, Seoul 120-749, Korea

¹¹ Ibaraki University, 2-1-1 Bunkyo, Mito, Ibaraki 310-8512, Japan

アレイ拡張に向けての KaVA AGN Large Program 枠の利用 (2016 Mar)

KVN 13/7/3/2mm VLBI



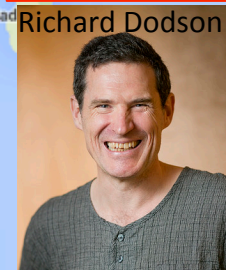
Simultaneous
VLBI with KVN:



Zhiqiang Shen



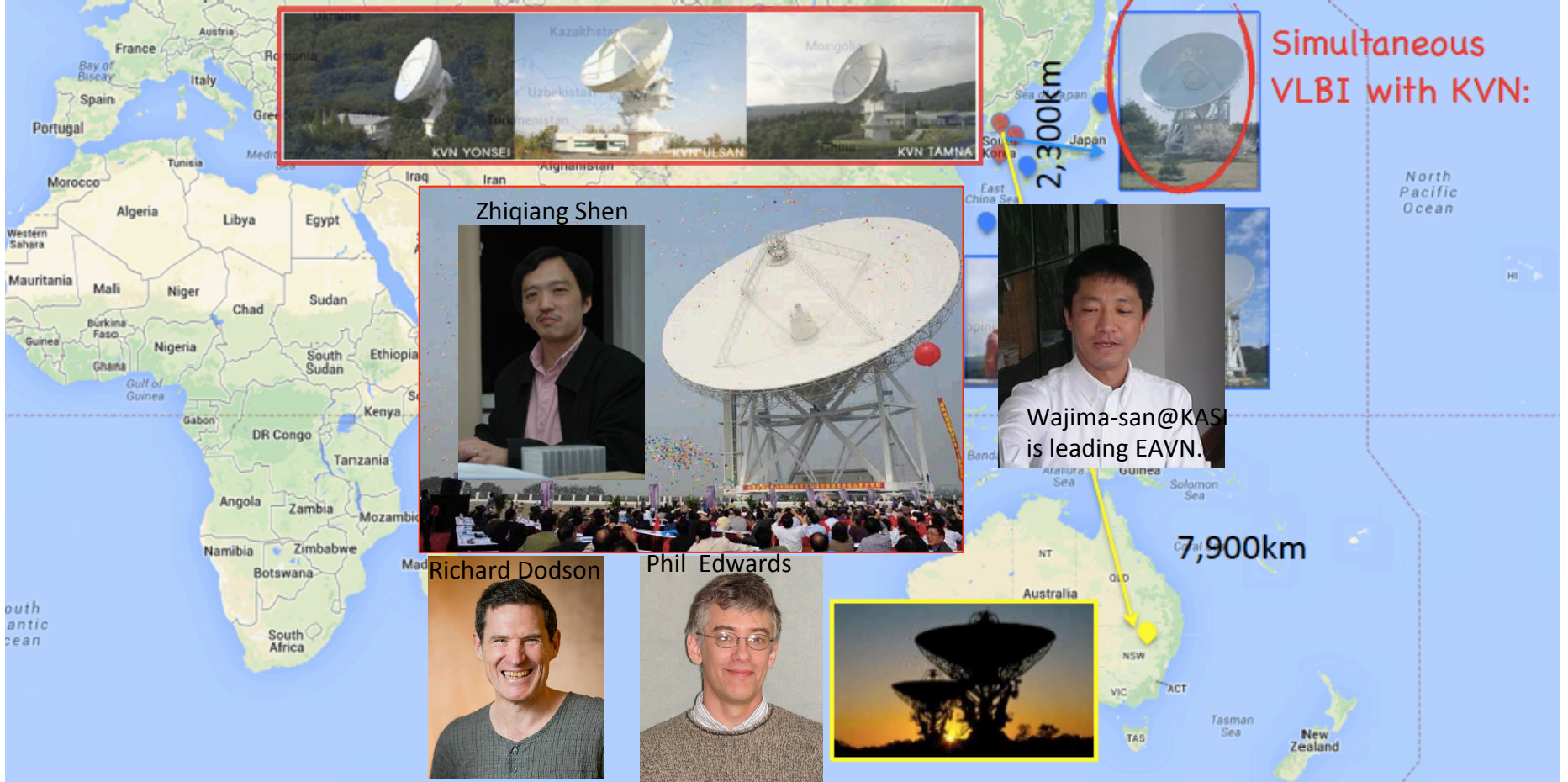
Wajima-san@KAS
is leading EAVN.



Richard Dodson



Phil Edwards



Summary

- KaVA AGN LP has been **successfully start** and we explore M87 and Sgr A* in great details.
 - ✓ M87 monitor 2014 (Hada+ in prep)
 - ✓ Sgr A* proceedings (Zhao+)
 - ✓ M87 LP in 2016 (Park+; Ro+ in progress)
- We also make efforts for international observations
 - ✓ test observations with **Chinese and Australian** stations.
 - ✓ In March 2017, simultaneous obs. w/ **EHT**.