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Gamma-ray binaries는 밀집성(중성자별과 블랙홀)과 질량이 큰 동반성 (>20 Msun)이 서로 공전하는 시스템이다. 이러한 시스템은 X선 영역에서 공전 주기에 따른 변광을 보이는 특징을 갖고 있는데, 이를 설명하기 위해 intrabinary shock(IBS) 모델을 이용한다. IBS는 두 천체의 항성풍이 상호작용하여 만들어내는 shock인데, 이 shock에서 가속된 입자들이 싱크로트론 기작을 통하여 X선 복사를 한다고 알려져 있다. 복사의 강도는 shock의 기하구조 변화 때문에 밀집성의 공전 위상에 따라서 주기적으로 변하는데, 이를 모형화하여 관측 데이터와 비교함으로써 궤도와 shock의 특성을 알아낼 수 있다. 이 발표에서는 IBS 모델을 설명하고, 이 모델을 매우 복잡한 X선 광도곡선을 보이는 gamma-ray binaries 중 하나인 HESS J0632+057에 적용한다. 그 결과로 이 천체계의 궤도를 추정하고, 동반성 disk와 shock의 상호작용 특성을 파악해보았다.

천문우주관측기술

[구 AT-01] Development of Gravitational Wave Detection Technology at KASI (한국천문연구원의 중력파 검출기술 개발)

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For the first time in Korea, we are developing technology for gravitational wave (GW) detectors as a major R&D program. Our main research target is quantum noise reduction technology which can enhance the sensitivity of a GW detector beyond its limit by classical physics. Technology of generating squeezed vacuum state of light (SQZ) can suppress quantum noise (shot noise at higher frequencies and radiation pressure noise at lower frequencies) of laser interferometer type GW detectors. Squeezing technology has recently started being used for GW detectors and becoming necessary and key components. Our ultimate goal is to participate and make contribution to international collaborations for upgrade of existing GW detectors and construction of next generation GW detectors. This presentation will summarize our results in 2020 and plan for the upcoming years. Technical details will be presented in other family talks.

[구 AT-02] Status of squeezed vacuum experiment and introduction to EPR (한국천문연구원의 진공양자조임 광원 개발 및 EPR 실험 소개)

Chang-Hee Kim (김창희), Sungho Lee (이성호), June Gyu Park (박준규), Yunjong Kim (김윤종), Ueejeong Jeong (정의정), Soonkyu Je (제순규), Hyeon Cheol Seong (성현철), Jeong-Yeol Han (한정열)
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One of the main limitations to the ground- based gravitational-wave (GW) detector sensitivity is quantum noise, which is induced by vacuum fluctuations entering the detector output port. The replacement of this ordinary vacuum field with a squeezed vacuum field has proven to be effective approach to mitigate the quantum noise in the interferometer detector and it is currently used in advanced detectors. However, the current frequency-independent squeezed vacuum cannot reduce quantum radiation pressure noise at low frequencies. A possible solution to reduce quantum noise in the broadband spectrum is the injection of frequency-dependent squeezed (FDS) vacuum. We will report the current status of squeezing experiment at KASI and introduce to the EPR (Einstein-Podolsky-Rosen) entangled state of light, which can realize FDS light without the need for an additional, external cavity.

[구 AT-03] Frequency dependent squeezing for gravitational wave detectors using filter cavity and international collaboration of a filter cavity project for KAGRA (중력파 검출기의 양자 잡음 저감을 위한 필터 공동기 기반 주파수 의존 양자조임 기술과 KAGRA의 필터 공동기 제작을 위한 국제협력연구)

June Gyu Park (박준규), Sungho Lee (이성호), Chang-Hee Kim (김창희), Yunjong Kim (김윤종), Ueejeong Jeong (정의정), Soonkyu Je (제순규), Hyeon Cheol Seong (성현철), Jeong-Yeol Han (한정열)
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Radiation pressure noise of photon and photon shot noise are quantum noise limitation in interferometric gravita-tional wave detectors. Since relationship between the two noises is position and momentum of the Heisenberg uncertainty principle, quantum non-demolition (QND) technique is required to reduce the two noises at the same time. Frequency dependent squeezing using a filter cavity is one of realistic solutions for QND measurement and experimental results show that its cutting-edge performance is sufficient to apply to the current gravitational wave detectors. A 300m filter cavity is under construction at adv-LIGO. KAGRA (gravitational wave detector in Japan) has also started international collaboration to build a filter cavity. Recently we joined the filter cavity project for KAGRA. Current status of squeezing and filter cavity research at KASI and details of the KAGRA filter cavity project will be presented.

[구 AT-04] Development of Transformable Reflective Telescope Kit Using Aluminum Profile and Isogrid Struture

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본 발표에서는 Transformable Reflective Telescope (TRT kit)의 새로운 버전을 소개한다. TRT kit는 기본형인 뉴턴식 반사망원경에서 부경 교체를 통해 카세그레인식, 그레고리식으로 간단하게 변형 할 수 있는 광학 실험장치이다. 본 장치는 주로 망원경 교육이나 광학계 개발에필요한 실험에 활용된다. 모듈화 설계를 통해서 여러 종류의 광학계를 쉽게 탈착하여 다양한 실험을 할 수 있다. 광기계부는 정밀하게 제작된 알루미늄 프로파일과 Isogrid구조를 채택하여 경량화 구조로 설계되었다. 이러한 경량부품들을 통해 이전 버전보다 50~70%의 중량 감소율을 달성하였다. 유한요소해석 결과 경량화된 뉴턴식 TRT kit는 이전 버전과 비교해서 자체 하중에 의한 최대 구조 변형이 0.11mm에서 0.023mm로 감소하였다. 부경 지지대 설계에는 자체 하중으로 인한 변형을 최소화하기 위해 트러스 (Truss) 구조가 도입되었다. 부경부의 자체 하중으로 인한 변형은 기존의 80μm에서 21μm로 감소하였다. 또한, 십자 레이저 정렬 장치가 추가되어 뉴턴식과 카세그레인식에서 공차 1.5' 이내로 광학계 정렬이 가능하다.

[구 AT-05] Realities of Gemini Band3 Program

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We, on behalf of Korean Gemini Office (KGO), present the comprehensive knowledge on the Gemini Band 3 program and introduce KGO's activities to promote research of Korean community utilizing Band 3 programs. We first describe the role and realities of Band 3 programs in comparison with Band 1 and 2. Then, we will provide useful suggestions for preparing Band 3 programs and introduce a few selected cases that successfully use the Band 3 time. In addition to Band 3, we will briefly summarize other proposal opportunities including the Fast Turnaround and Poor Weather Proposals.

[구 AT-06] Optomechanical Design and Structural Analysis of Linear Astigmatism Free – Three Mirror System Telescope for CubeSat and Unmanned Aerial Vehicle

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We are developing an optomechanical design of infrared telescope for the CubeSat and Unmanned Aerial Vehicle (UAV) which adapts the Linear Astigmatism Free- Three Mirror System in the confocal off-axis condition. The small entrance pupil (diameter of 40 mm) and the fast telescope (f-number of 1.9) can survey large areas. The telescope structure consists of three mirror modules and a sensor module, which are assembled on the base frame. The mirror structure has duplex layers to minimize a surface deformation and physical size of a mirror mount. All the optomechanical parts and three freeform mirrors are made from the same material, i.e., aluminum 6061-T6. The Coefficient of Thermal Expansion matching single material structure makes the imaging performance to be independent of the thermal expansion. We investigated structural characteristics against external loads through Finite Element Analysis. We confirmed the mirror surface distortion by the gravity and screw tightening, and the overall contraction/expansion following the external temperature environment change (from -30˚C to +30˚C).

[구 AT-07] Optomechanical Design and Structure Analysis of Prototype Siderostat for Testing Local Volume Mapper Telescope Control System

Sunwoo Lee[1], Jimin Han[1], Hojae Ahn[1], Changgon Kim[1], Mingyeong Yang[1], Tae-geun Ji[1], Sumin Lee[1],