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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)

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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