

follows the coalescence of two holes, it is worth estimating timescales of dynamical evolution of such systems in various situations. The rapid decrease of accretion rate was recently suggested by Park and Vishniac and, if it is true, the lifetime of the system can be extended significantly. This suggests a possibility that, at least, few of the coalescences can occur in nearby galactic nuclei.

### Setting Limits on $q_0$ from Gravitational Lensing

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We consider gravitational lensing by galaxies in a wide variety of cosmological models. We model galaxies (with their heavy halos) as singular isothermal spheres. As the QSO approaches the antipode, which can occur in models with large values of cosmological constant  $\Lambda$ , the cross sections for lensing blow up. For a QSO beyond the antipode we can obtain an overfocused case. In this case, when a lensing event occurs, only one arbitrary dim image coincident with the position of the lensing galaxy nucleus is seen. If galaxy rotation curves are always flat or slowly rising, as appears to be the case for most galaxies, the overfocused case *always produces one image*. The existence of the apparently normally lensed case QSO 2016 with  $z_q=3.27$  and  $z_L=1.01$  indicates that the antipodal redshift  $z_p$  is greater than 3.27. The seven observed lensing cases taken together, as well as the fact that no large separation galactic lenses have been found  $z_p > 3.27$ , implying that  $q_0 > -2.3$ .

### Black Holes or Dark Clusters in M31 and M32?

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Recent spectroscopic data and dynamical modeling indicate the presence of dark matter within the nuclei of M31 and M32. If these nuclei do not contain massive black holes, the most likely alternative form for the dark matter is a cluster of low-mass stars or degenerate remnants. Here we show that simple physical considerations place lower limits  $\sim 0.1''$  on the half-mass radii of such clusters if they have survived in their present form over much of the age of the universe. Therefore, Space Telescope observations should rule out such clusters, or resolve them.

### Dynamical Model Calculation of the Spherical Galaxy Having Massive Halo

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Using the Schwarzschild's linear programming technique, we obtained the general solution of the collisionless Boltzmann equation describing the spherical galaxy in the dynamical equilibrium state. From this calculation we have confirmed the existence of isotropic stellar systems which include dark halo. The flattening of the velocity dispersions in elliptical galaxies can be explained

as the increase of  $M/L$  in this dark matter. The space density distribution of this dark matter shows that  $r_c$  of the dark matter is smaller than  $r_c$  of the galaxy.

## A Portable Photoelectric Photometer System for Small Telescopes

강 용 우 · 안 홍 배  
(부산대학교)

A portable photoelectric photometer system is developed for the observations with small telescopes. We used photo-transistor and three-color photosensor for detecting parts. The faint signals from the sensor are fed to a DC amplifier attached to the photometer before being sent to computer or chart recorder for data recording. Several test observations of bright stars using 15 cm refractor at Pusan University show that our system can be used to observe stars brighter than 2.5 magnitude. We discuss the ways of obtaining better sensitivity in the future.

## 천문대 후보지에서의 기상 및 천체관측 결과분석

김강민 · 전영범 · 이재한 · 심경진  
(천문우주과학연구소)

천문우주과학연구소에서는 전국의 80여개 산을 답사한 결과 덕가산(강원도 원성군 소재; 702m), 보현산(경북 영천군 소재; 1,124m), 화왕산(경남 창원군 소재; 757m)과 기존의 소백산(충북 단양군 소재; 1,360m), 네곳을 1.8m 광학 망원경 천문대의 1차 후보지로 선정하였다.

이들 후보지에서 1989년 4월부터 1년간 기상관측을 수행하였고 산정에서의 천체관측은 1989년 10월에서 11월에 걸쳐 수행하였으며 이를 분석한 결과는 보현산이 다른 산에 비해 전체적으로 관측환경이 양호함을 보여주고 있다.

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## <研究論文>

### Dynamical Evolution of Globular Clusters Due to Diffusion and Tide

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We investigate the tidal evolution of globular clusters subject to various degrees of internal diffusion processes.