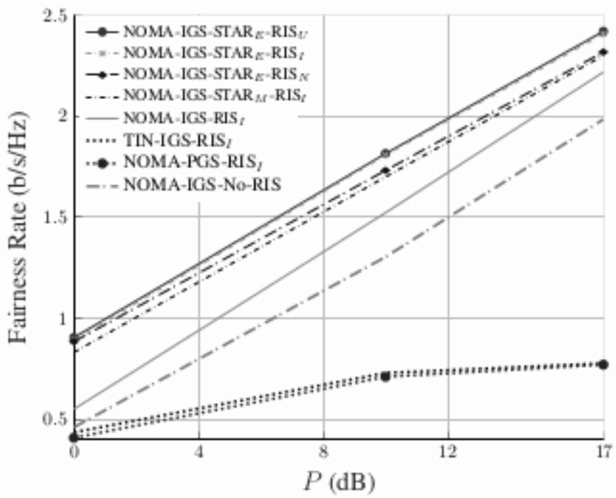

Fig. 2: The average fairness rate versus P for $N_{BS} = N_u = 2$, $N_{RIS} = 60$, and $K = 3$.

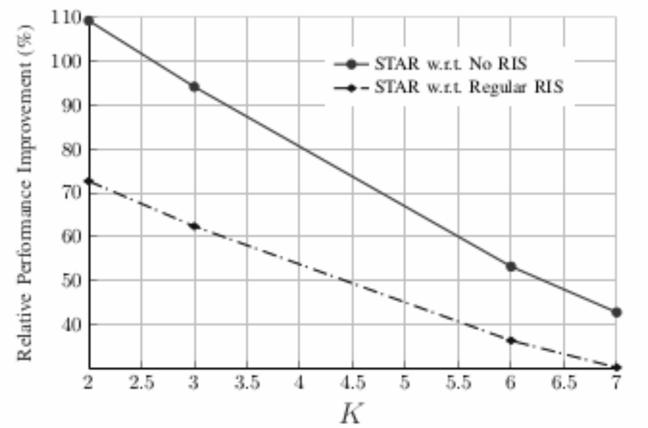

Fig. 3: The average performance improvement by employing STAR-RIS versus K for $N_{BS} = N_u = 2$, and $N_{RIS} = 60$.

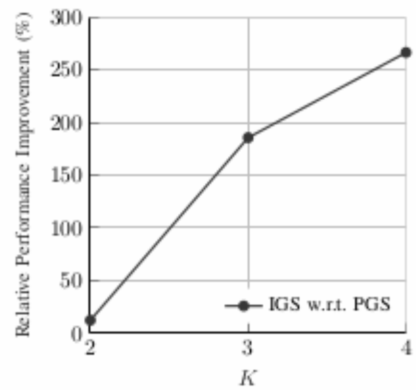

Fig. 4: IGS with respect to PGS.

Fig. 5: The average performance improvement by employing IGS versus K for $N_{BS} = N_u = 2$, and $N_{RIS} = 60$.

only the CCUs and cannot cover the CEUs. However, a STAR-RIS can cover all the users due to its 360° coverage. In order to have a fair comparison, we assume that the number of RIS components for both the regular and STAR-RISs are the same. To better investigate the role of IGS, we divide the numerical results into two subsection. In the first subsection, we investigate the role of IGS as an interference-management technique. To this end, we consider perfect devices since IQI can increase the benefits of IGS, as shown in [**?**], [**?**]. Then, we consider the impact of IQI and the importance of HWI-aware techniques in Section IV.B.

A. Impact of interference on spectral efficiency

Fig. **??** shows the average fairness rate versus P for $N_{BS} = N_u = 2$, $N_{RIS} = 60$, and $K = 3$. As can be observed, the proposed NOMA-based IGS scheme with ES and the feasibility set $\mathcal{T}_U$ outperforms the other schemes, while the NOMA-based IGS scheme with ES and $\mathcal{T}_I$ performs very close to the ES scheme with $\mathcal{T}_U$. Moreover, we observe that the MS scheme performs very close to the ES schemes, and the performance gap between the MS scheme and the ES scheme with the feasibility set $\mathcal{T}_N$ is minor, especially at higher SNR regimes. Note that the computational and/or implementation complexities of MS schemes are less than ES schemes, which can compensate the small performance gap, comparing to the ES schemes.

In Fig. **??**, we can also observe that IGS and/or NOMA can highly improve the system performance. Interestingly, the NOMA-based IGS scheme without RIS can significantly outperform the NOMA-based PGS scheme as well as the IGS scheme with TIN for RIS-assisted systems. This result, indeed, shows the importance of interference-management techniques in highly overloaded STAR-RIS-assisted systems. Moreover, it shows that RIS alone cannot handle interference in overloaded systems, and we have to employ powerful interference-management techniques to fully reap (STAR-)RIS benefits.

Fig. **??** shows the benefits of employing STAR-RIS versus K for $N_{BS} = N_u = 2$, and $N_{RIS} = 60$. As can be observed, STAR-RIS can significantly improve the system performance even over a regular RIS. For a fixed number of STAR-RIS components, the benefits of STAR-RIS decrease with the number of users. However, the benefits are still significant when there are less than five components per users, i.e., when there are 14 users in the network (for $K = 7$). Note that the total number of users is $2K$.

Fig. **??** shows the benefits of employing IGS versus K for $N_{BS} = N_u = 2$, and $N_{RIS} = 60$. The IGS benefits are computed by comparing the performance of the NOMA-based IGS scheme with the NOMA-based PGS scheme for RIS-assisted systems.As can be observed, IGS can significantly improve the system performance. Furthermore, the benefits of IGS and/or NOMA increase with the number of users, which is in line with our previous studies in [**?**], [**?**]. The reason is that, the higher the number users is, the higher interference exists, which makes the use of advanced interference management techniques more necessary and their benefit more significant.