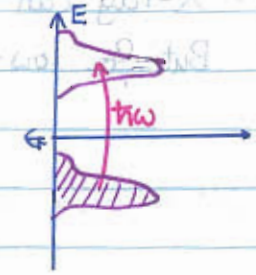
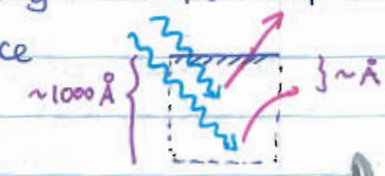
ARPES (I) [Dassau]



- photoemission — joint density of state
  - ▲ $E_{kin} = \hbar\omega - \Phi - |E_B|$
  - ▲ Primary e^- — no scattering
    Secondary e^- — scattered, give rise to background
    Secondary e^- most prominent as energy ↘.

- Angular-resolved ⟹ k-dependence of electronic structure
  - ▲ k parallel to surface is conserved.

- Light can go through 1000 Å in, but outgoing e^- is from a few Å from the surface ⟹ Rely on "clean" surface



- Intensity $\propto \sum_{i,f} |\langle f|\vec{p}\cdot\vec{A}|i\rangle|^2 \underbrace{A(\vec{k},E)}_{\text{spectral fcn}} f(E)$
  - ▲ Intensity is higher (width narrower) as momentum approaches Fermi surface.

- "Three step model" for photoemission (Spicer)
  (1) photoexcitation of e^- ("deep" inside surface) [transition between bands in the bulk]
  (2) travel through to the surface [generation of secondary e^-]
  (3) go out of surface (overcome work function) [map crystal momentum to true momentum]

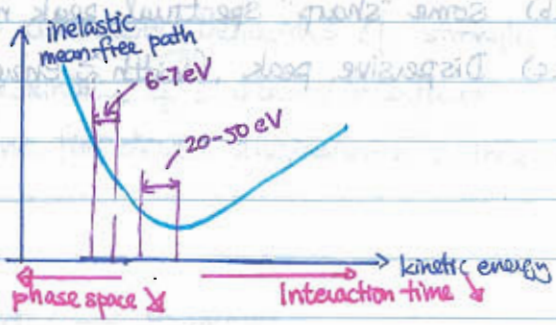
- Momentum Conservation is up to reciprocal lattice vector $\vec{G}$
  - ▲ Incident photon has essentially no momentum compare to lattice scale

- For simple case
$$\begin{cases} \hbar k_{//} = \left[2m\left(E_i + \hbar\omega - e\Phi\right)\right]^{1/2} \cdot \sin\theta \\ \hbar k_\perp = \left[2m\left((E_i + \hbar\omega - e\Phi)\cos^2\theta - \underbrace{E_0 - e\Phi}_{=V_0}\right)\right]^{1/2} \end{cases}$$

- 2D compounds (easier!)
  - ▲ Can ignore k_z
  - ▲ Less final state boardening
  - ▲ Surface (usually) better cleaved.

- There are two work-functions — that of sample & analyzer. The analyzer work-function is easier to determine. To determine Φ of sample. Best way is to measure the onset for low-energy incident light.

- Suface sensitivity



- Typical experiments are done using synchrotron.

- Sample size — usually ~1mm. But nanoARPES can get down to ~50μm. Still smaller than that needed for neutron

- Different photon polaization can be used to pick out symmetry of states (some matrix elements become 0 by symmetry) when inject along high symmetry direction.

- Sudden approximation does not pose major issue, even down to 6eV (old rule of thumb ~ 15-20eV), except there may be lost features.

- The peak of energy distribution curve (EDC) usually come at energy slightly below ϵ_k, since $I \sim A(k,\omega) \cdot n_f(\omega)$
  - ▲ Width of peak ~ $\hbar/\tau$, τ is lifetime of quasiparticle.

- For high-T_c SC, Lorentzian gives good fit when convolve with fermi distribution $n_f(\omega)$, together with added background. This may be improved by Fermi liquid / Gutzwiller projected $A(\vec{k},\omega)$.

- Coherent vs. Incoherent States
  - ▲ Various definitions of "coherent":
    - (a) true Landau quasiparticle
    - (b) some "sharp" spectrual peak near ϵ_F
    - (c) Dispersive peak, even if it is board (width $\approx$ energy)